Social Enterprises as Agents of Technological Change:

Case Studies from Tanzania

by

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ABSTRACT

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This thesis explores the potential role of social enterprises as agents of technological change in developing societies. By 'agents' it is meant active participants in processes of conceiving and implementing new technological solutions for communities. The thesis argues that technology-oriented social enterprises can be effective agents of technology localization which includes diffusing, supporting and adapting technologies for local conditions. Technology localization is a main variable in the pursuit of technological autonomy in developing societies. Technological autonomy refers to the endogenous capacity of developing countries for generating, transferring and managing technologies on their own terms in support of economic and human development. The thesis examines 6 case studies of technology-oriented social enterprises in rural regions of Tanzania. The cases were headquartered in Tanzania but operated in other East African countries as well (Kenya, Uganda and Rwanda). To assess the effectiveness of the cases as agents of technology localization, they were assessed for their engagement in the activities of diffusion, support and adaptation, who they engaged with in these activities and whether their clients showed relative satisfaction with the technological change that the social enterprises promoted. Field data were collected from December 2014 to September 2015, through interviews with the staff, clients and partners of the social enterprises, as well as through field observations and scanning of accessible reports and documents of social enterprises and their partner organizations. The field work also identified three distinct models of diffusion represented by the cases: microfranchising, sector-enterprise cultivation, and business-technology incubation. All three models appeared effective as approaches to the diffusion of new technologies.

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As this extensive and long training course of hands-on scholarship comes close to conclusion, one looks back and realizes that, over time, much knowledge was learned and many skills of scholarship were harnessed, hopefully to be used wisely for the rest of one's life and career. That cumulative gain of knowledge and skills is only fully appreciated at the near conclusion.

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I thank my mother, as I consider this as much her achievement as it is mine. Without her care, and my witnessing of her embodiment of perseverance and patience, I doubt that I would have made it this far. I thank my father, for introducing me, at an early age, to the fascinating world of architecture and building. I later came to realize and connect that technological development has many similarities to that world (at least in my head), which consequently shaped the way I think about it. I thank my grandfather, for passing down to me the love of diverse reading. It came in handy with the multidisciplinary and interdisciplinary path I chose for my academic learning.

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CHAPTER I: INTRODUCTION

This thesis explores the potential role of social enterprises as agents of technological change in developing societies. The term ‘agents’ refers to active participants in processes of conceiving and implementing new technological solutions for communities. The three activities of technology diffusion to communities, provision of institutional support for such diffusion efforts, and adaptation of technologies to local conditions are termed “localization”. The thesis examines the work of technology-oriented social enterprises in rural regions of Tanzania and concludes that technology oriented social enterprises can be effective agents of technology localization. To assess the effectiveness of the cases as agents of technology localization, the research asked whether the cases demonstrated ongoing engagement in the activities of diffusion, support and adaptation, whether they demonstrated competence in engaging what have been termed “early adopters” of innovations in the diffusion process, and whether their clients showed relative satisfaction with the technological change that they experienced.

Agents of technological change are important because they can actualize and accelerate technological change processes. The thesis assumes that it is imperative for developing societies to build endogenous capacity for creating and transferring technologies on their own terms as they seek economic and human development. Hence, developing societies need technological change agents. The research assessed the potential of social enterprises as technological change agents and concludes that they have been effective in localizing technologies in rural Tanzania.

Background

In the BBC documentary series, *The Africans: A triple heritage*, prepared and hosted by the late Ali Mazrui, in part 4 of the series (1986), Mazrui took the viewers through big, state-of-the-art industrial factories in two West African countries. Those factories were built right after political independence was gained, and they were built from the ground-up paid for by their respective states. They were built to represent a proud leap forward by the newly independent countries towards the era of modern industrialization. However, people and products were missing from the floors of those factories. Mazrui walked through these empty factory floors and told their story. They were decommissioned plants that lasted for only short periods of time before the governments realized they were running at a cost higher than their return, with no foreseen change in that situation in the near future. Being high-tech plants, they were not only commissioned and built by western corporations; they were also operated by them on contracts with the government. The plants were foreign plants on African soil, and they were unable to serve the development priorities of their host countries. In the end a tough lesson was learned (hopefully) the hard way.

Processes of technological change pose many challenges for developing societies. They tend to be complex and multi-faceted, involving numerous variables, agents, and contexts. However, they are a critical part of economic and human development for all societies. Historical evidence shows a strong correlation between technological development and human development (Hill & Dhanda 2003). The UNDP shows how the seminal advances in human development in the 20th century were largely attributed to technological improvements and breakthroughs, in different sectors (e.g. health and hygiene, agriculture, transportation, etc.) (UNDP 2001). In terms of economic development the terminology of ‘industrialized economies’

is widely used to refer to technologically advanced, wealthy countries. Many development solutions involve people and technologies working in combined efforts that form functional wholes; sometimes referred to as technosocial systems (Woodhouse & Patton 2004).

Development in different sectors requires different stimulants and interventions depending on the social and cultural context. For example, in Africa, agriculture has had slow rates of adoption of new technologies and minimal increases in productivity (Jones 2009). Researchers have pointed to subjective and social challenges facing agricultural technology adoption in Africa, such as farmers' negative perceptions of technological changes, or cultural barriers to accepting them (Stamp 1990; Simalenga 1999; Adesina 1995; Rauniyar 1992). Dercon and Christiaensen (2011) demonstrate that besides subjective resistance there are also risks that farmers consider such as crude cost-benefit analyses and the multitude of household priorities, which lead many of them to avoid adopting new technologies. The story of Africa and agriculture resonates, in varying degrees, with other developing regions such as Southeast Asia and Latin America (Binswanger 1986; Adeel et al. 2008; Martinez-Torres et al. 2010).

In contrast, information and communication technologies (ICTs) have in a relatively short period experienced rapid adoption in developing societies around the world. ICTs have been adopted in healthcare, tourism, small and medium-sized enterprises, and in education (UNDP 2001; Lekoko and Semali 2012; Rensburg et al. 2008; Nasir et al. 2011). Between the two extremes of modern agricultural technologies and ICTs there are varieties of other technology sectors with different levels of adoption in developing societies, such as water and sanitation (Adeel et al. 2008; Fidiel 2005), alternative energy (Williams et al. 2011), and small industries (Dengu et al. 2006).

Processes of technological change and industrialization in various societies show varying patterns and degrees of success. Measures of technological innovation capacity and output such as the Global Innovation Index (GII)[1] and the Technology Achievement Index (TAI)[2] suggest that there is no roadmap appropriate for all countries pursuing technological progression. The historical paths of industrialization followed by the USA, the UK, Germany, Russia, China, Japan, India and Brazil are dissimilar and largely influenced by local variables, including factor endowments, socioeconomic institutions, market relations, policies and sociopolitical histories. In addition, these indices show that some developing regions have made almost no technological progress over long periods of time, leaving a huge gap between them and countries that have progressed (Desai et al. 2002). In spite of this gap, the indices suggest that technological change is building up globally. Despite serious setbacks in some contexts, technological knowledge and skills of local populations and global interconnectedness of technological markets, procedures and R&D methods are increasing overall (Desai et al. 2002; Nasir et al. 2011). There are good reasons why most technological capacity assessments focus on national scales, since calculating indicators at national levels is more accessible. Yet it makes sense as well to assess technological capacity (and achievements) with smaller and more 'organic' social aggregates – i.e. aggregates formed around ecological or socioeconomic relations such as communities of geo-ecological regions and industrial clusters. Some attempts at explaining this phenomenon refer to evidence that such social aggregates tend to correlate with 'technological hubs' within countries. According to the Global Development Index Report, these hubs – such as Silicon Valley-type

[1] See the 2013 ranking of countries, by the Global Innovation Index, here: http://strat-staging.com/content.aspx?page=data-analysis

[2] The Technology Achievement Index (TAI) is used by the UNDP (United Nations Development Programme) to measure a country's technological capacity and progress in comparison to other countries. The TAI uses four dimensions of technological capacity: creation of new technology; diffusion of recent innovations; diffusion of old innovations that are still fundamental for industrialization; and the building of human skills base for technology origination and adoption. Each one of the dimensions has two statistical sub-indicators (Desai et al. 2002).

industrial clusters – are usually responsible for painting the entire country's technology mode or level suggesting that the mode is evenly distributed across the whole country when it is actually concentrated in a few places (Dutta & Lanvin 2013). There are indicators of a statistically significant positive correlation between technological achievement and human development—presented in a comparison between the UNDP-initiated indices: Technology Achievement Index and Human Development Index (Hill & Dhanda 2003, 29). The technology divide between countries of the world appears to be a strong indicator of the human development divide as well.

From this broad overview several general ideas emerge: 1) that technological change is important for development, 2) that it evolves in multiple ways; 3) that it can be measured in a variety of ways; 4) that there may be alternative ways to explain the main features of its evolution and diversity; and 5) that sustained economic development requires increasing local capacity to use, control and maintain technosocial systems.

Discussion continues in international development circles about the importance of developing and increasing endogenous technological capacities (see for example Shaw 2002; Adeel, Schuster and Bigas 2008; Nasir et al. 2011). The discussion is not so much about whether endogenous capacities are important, but about what levels of them are needed in order to advance the economic and human development agenda. This thesis assumes that higher levels of endogenous capacities are necessary to achieve development in key sectors of technology and science, such as agriculture, energy, water supply, health and hygiene, infrastructure and basic industries (Mazrui 1986; Haug 1992; Nyerere 1968 and 2011; STIPRO 2010; Page 2016).

Problem Statement

Effective agents of technological change are necessary for development. While social enterprises have received significant scholarly attention in Europe and North America, they have not yet

received similar attention elsewhere. Technology-oriented social enterprises in some developing societies have received high praise and support in the last few years but there is limited research published on their actual contribution to technological development in the region. Recently in developing countries new models of social enterprise have begun to engage in localizing technologies in agriculture, alternative energy, and ICTs in rural communities. Assessing their effectiveness as agents of technological change is required to inform development planning and policies.

Research Context

The technological change literature is relatively diverse and abundant, yet not sufficiently integrated. There is considerable scholarship on the theory and historical analysis of developing technological capabilities in firms and national systems (Lall 1992; Wolff 1999; Kim & Nelson 2000; Oyelaran-Oyeyinka & McCormick 2007; Mazzucato 2013). There is work on technological change models, as they relate to dynamics of markets, resources and stimulation of industrial innovation (Dosi 1982; Arthur 1989; Ruttan 1997). There are established fields that relate to technological change and overlap with it, such as diffusion of innovations (Wejnert 2002; Rogers 2003; Huh & Kim 2008; Haider & Kreps 2010; Zanello et al. 2015) and institutional economics of technology affairs (Polanyi 1944; Rosenberg 1982; Binswanger 1986; Kroszner 1987; Haug 1992; Page 2016). There is also an influential literature on understanding the phenomenon of technology as it pertains to both developed and developing societies (Mumford 1967 and 1970; Galtung 1979; Franklin 1989; Aunger 2010; Franssen et al. 2013). As for developing societies there is literature on the dichotomies between traditional and modern technologies (Hyman 1987; Gamser 1988; Scott 1999; Roy 2002; Adeel, Schuster and Bigas 2008) as well as the role of national and international dynamics and technology transfer, in

affecting technological development through various factors, such as development policies and international relations (Morehouse 1979; Nyerere 1998; UNDP 2001; Shaw 2002; Diyamett & Risha 2015).

Few works connect the multiple scholarly fields mentioned above through conceptual frameworks that integrate and map big pictures. One such framework is the National Innovation System (NIS) framework, which aims to organize the productive forces and structures, and the flow of information and skills in a country, in order to increase the output of innovative solutions to development constraints (Maharajh, Scerri and Sibanda 2013). In that framework, STI (science, technology and innovation) play a central role, and thus require strategic investment. At the policy level the NIS will include careful investments in education systems, enterprise support and labour markets (Lundvall 1992). The NIS framework can be used in any country and be adjusted to its level of development. Many countries are careful to devise and improve their own NISs as part of their national plans. The NIS framework operates only at the national policy level by default and thus contributes to the design of macroeconomic policies. It is also vague on key technological activities that are not considered 'innovative', but customary or traditional, even if they are recognised as important for the particular context. Another framework has been developed by Aubert (2005) for promoting innovations in developing countries. Based on new intuitional economic thought, this framework is largely a policy blueprint for developing countries for strengthening the technological capabilities of their firms to innovate and compete in national and international markets. Aubert's framework makes recommendations on IPR (Intellectual Property Rights) regulations and how to address the brain drain of R&D professionals from developing to OECD countries. Overall it presents itself as a framework for

promoting innovations, but offers little specificity to identifying main concepts, goals, priorities and relations.

The framework of technological autonomy, presented in the next chapter, builds on the literature discussed above and seeks to ameliorate some of the mentioned shortcomings of other conceptual frameworks. It describes processes of technological change in developing societies. If developing societies seek to improve levels of human and economic development it will be necessary for them to develop an endogenous capacity to oversee technological affairs. This capacity is termed “technological autonomy”. Such autonomy includes a “strengthened autonomous capacity for creating, acquiring, adapting and using technology” (Morehouse 1979, 387) and an autonomous decision-making capacity to plan and manage the local affairs of industrial and infrastructural development. The framework presents two main variables that lead to technological autonomy: technology localization and technological capabilities. Technology localization consists of three activities: diffusion, institutional support, and technical adaptation. Technological capabilities, on the other hand, consist of: production activities, investment activities and networking of actors who generate technological innovations and knowledge. Advances in technology localization and technological capabilities work together to advance a society along the path towards technological autonomy. Agents of technological change – such as the state, private industries, and non-governmental organizations – actualize and set the process of technological change in motion. They activate and support – i.e. operationalize – the variables of the framework. The proposed framework identifies the main elements of technological change and helps to visualize and connect its goals and objectives in developing societies.

In some contexts, conditions call for emerging agents of technological change to fill some gaps that existing agents have not been able to fill. The thesis argues that social enterprises are potential agents of technological change who may advance technology localization and thus contribute to advancing towards technological autonomy.

Objectives

Social enterprises were chosen for this study because of their unique mission and approach, their recent arrival on the rural development scene in developing countries, their engagement in the marketing of a variety of technologies in rural areas, and because their contribution to technological change in the region has not yet been clarified. Social enterprises are considered part of 'the third sector', which includes NGOs, civil society organizations, as well as many cooperatives. However, they differ from others in the third sector in that they combine a social mission with business rigor, and that their income-generating activities are integral to their non-profit goals. These qualities should give social enterprises a capacity to fill gaps in technology localization in developing countries; gaps that other technological change agents, such as the public sector and private industries, are not filling.

The main research question for the field study was: *are social enterprises effective agents of technology localization in developing societies?* To respond to the research question, the study set out to answer three sub-questions about social enterprises as agents of technology localization, and explored their responses in the context of rural Tanzania: 1) do social enterprises demonstrate involvement in the three activities of technology localization, which are diffusion, institutional support, and technical adaptation; 2) do the diffusion activities of social enterprises demonstrate success in identifying and engaging those described as "early adopters" of innovations (also known as the trendsetters in communities and the ones who often influence

the rest of their communities to adopt innovations); and 3) do the clients and partners of social enterprises give overall favourable accounts of the technological changes adopted or promoted. Case studies were selected from a number of active social enterprises in Tanzania from 2014 to 2015. The enterprises were based in Tanzania but operated in other East African countries as well (Kenya, Uganda and Rwanda). Several were recruited to participate and six of them accepted, along with some of their partner organizations. Data were collected through interviews with the staff, clients and partners of the social enterprises, as well as through field observations and literature scanning of accessible reports and documents of social enterprises and their partner organizations. Data were collected to answer the three sub-questions about social enterprises and technology localization. Analysis used Nvivo for qualitative data, along with MS Excel for descriptive statistics.

Main Conclusions

The findings support the claim that social enterprises can be effective agents of technology localization in Tanzania. The three sub-questions were answered positively for the social enterprises studied. The evidence suggested that the social enterprises surveyed demonstrated involvement in the three activities of technology localization. Their diffusion activities demonstrated success in identifying and engaging early adopters, and the clients and partners of the social enterprises studied gave overall favourable accounts of the technological changes they had adopted or promoted.

The study uncovered additional, relevant information. For instance, it was found that particular models of diffusion, such as microfranchising and technology-business incubation, were successful in diffusing technologies. It was also found that particular technology types have significant acceptability by rural communities. These included agricultural machinery and

sustainable energy technologies (e.g. solar lanterns, energy-efficient cookstoves, biogas digesters, and solar PV home systems). According to records, the acceptability of these technologies is recent, either due to lesser efforts of localization in the past or that some of these technologies are generally recent arrivals to rural Tanzania and East Africa.

Overall, the findings of this study support the argument that social enterprises can contribute to technological autonomy not only in East Africa but across the developing world.

Organization of the Thesis

Following this introduction, chapter II presents a conceptual framework in three sections: the first on technological change and development, the second on technological autonomy, and the third on social enterprises as potential agents of technological change. Chapter III presents the design and methodology of the field study, including a description of the data collected and how it was analyzed. Chapter IV presents the detailed findings on the main research question and sub-questions. Chapter V presents some additional findings from the field study. Chapter VI offers concluding remarks.

CHAPTER II: LITERATURE REVIEW AND CONCEPTURAL FRAMEWORK

This chapter presents a literature review on technological change and its dynamics. It is divided into three sections. The first explores, discusses and synthesizes the existing literature on technological change and development. It also provides a review of some of the main models of technological change and discusses their strengths, weaknesses and overlaps. The second section proposes a technological autonomy conceptual framework. The framework identifies the main variables of technological change – technological capabilities and technology localization – and how they interact as a society moves along a path from technological dependency to technological autonomy. The framework is operationalized by agents of technological change, the groups, organizations and bodies that set technological change in motion. The thesis proposes that the combination of the framework and the agents provides a valid theoretical lens for studying and explaining the process of moving a society or a specific sector towards technological autonomy, in various developing societies. This framework suggests that social enterprises, alongside the state and the private sector, can serve as potential agents of technological change in developing societies; particularly in activities of technology localization. The third section explores the potential of social enterprises as agents of technological change through identifying features and attributes of social enterprises that make them credible candidates to fill gaps in local technological development processes.

Defining Technology

Encyclopaedia Britannica defines technology as “the application of scientific knowledge to the practical aims of human life or, as it is sometimes phrased, to the change and manipulation of the human environment.” The Greek origins of the word come from the two words *techne* and *logos*,

with the first meaning ‘art, skill, craft’ and the second meaning ‘expression of’—rendering a somewhat literal meaning of ‘expression of skill, art, and craft’. However, writings that focus on technology and development and technological change have provided various and more elaborate definitions of technology.

Everett Rogers’ (2003) defines technology as, “a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome.” (p. 13). According to Rogers a technology would typically have two components: (1) a hardware aspect, represented by the material or physical embodiment of a tool; and (2) a software aspect, represented by the information base for the tool. An example would be the computer, where the hardware component is represented by the semiconductors, transistors, frame, etc., while the software component consists of the coded commands, instructions, and the package of operative information that allow users to utilize the computer to achieve certain outcomes. Other technologies of various degrees and kinds can also be showcased by this definition, such as animal-drawn ploughs—where the hardware is represented by animal power and the plough tool itself and the software aspect is represented by the human knowledge that combined and utilized the hardware in a particular arrangement to achieve a certain outcome. Johan Galtung (1979) offers another theoretical perspective, with some critique of Rogers’ approach.

> “A naive view of technology sees it merely as a question of tools (hardware) and skills and knowledge (software). These components are certainly important, but they are only the surface of technology, like the visible tip of the iceberg... Underlying knowledge there is a certain cognitive structure, a mental framework, a social cosmology, serving as the fertile soil in which the seeds of a certain type of knowledge may be planted and grow and generate new knowledge. And in order to use the tools, a certain behavioural structure is needed. Tools do not operate in a vacuum; they are man-made and man-used and require certain social arrangements to be operational.” (Galtung 1979, 6).

According to Galtung, technology consists of techniques and structures (as opposed to hardware and software). The techniques are the tools and know-how, while the structures are the social relations, or modes of production, within which the techniques are operational. Galtung adds a social dimension to the understanding of technology that Rogers' definition did not include.

Aunger (2010) argues that, whenever we talk about technology, artefacts have to be involved. Technology is "about interaction with artefacts in particular contexts of engagement." (p. 764). Artefacts, defined as crafted material entities of known use, are the centre of interaction between an animal and the material environment in ways which that animal sees as useful means to ends. It is similar to the hardware aspect in Roger's definition, but emphasizes human intervention to alter the material from its natural state. Only then it becomes an artefact.

In synthesis, this thesis defines technology as *artefacts built and used to reduce uncertainties related to particular problems within particular structures*. The remainder of this manuscript will use the term 'technology' and its derivatives in accordance with this synthesized definition, unless otherwise indicated.

TECHNOLOGICAL CHANGE

In developing societies, where economies are less industrialized, technological change processes are mainly influenced by three conditions: technology-institutional dynamics, the dichotomy between traditional and modern technology in key sectors, and development priorities of societies.

Technology and Institutions

Many writers on technological change agree with Galtung (1979) and identify a necessary interconnectedness between social institutions and technology (Visvanathan 2004). Social institutions refer to socioeconomic regulations, behavioral norms, incentives and expectations that constrain and shape human relations (Menard et al. 2005; Orrnert 2006; Hodgson 2004; Voss 2004). These social elements are 'institutions' when they persist through time. Hodgson defines institutions as "durable systems of established and embedded social rules that structure social interactions" (Hodgson 2007, 67), and North defines them as "humanly devised constraints to human interaction" (North 1990, 3). To Rogers (2003) institutions "define a range of tolerable behavior and serve as a guide or standard for the behavior of members of a social system" (p. 26). The elasticity of the term institution allows it to be used to describe social entities (such as organizations) as well as social arrangements that do not have a material representation (such as laws, values and norms). Institutions stem from culture, belief systems and established common rules of conduct and 'doing business' (written or unwritten). They are structures that embed culture and laws, and thus to use "institution" is to evoke both structure and culture. Therefore, we can reasonably speak of cultural institutions, legal institutions, economic institutions, etc., all as variations of social institutions.

Understanding processes of technological change requires an understanding of the interdependence of technological knowledge, material resources and social context (Galtung 1979; Shaw 2002; Eisler 2002). The concept of 'technological embeddedness' captures this interconnectedness. It is drawn from the concept of embeddedness in the work of Polanyi (1944, 1957 and 1968), Hopkins (1957), Dalton (1990), Harriss (2003), and Hyden (2006), which refers to how economic activities and processes are usually dependent upon social institutions.

Technological embeddedness implies that, to be sustainable, technological choices need to be compatible with the socioeconomic and cultural structures within which they operate. Rogers (2003) suggests that the adoption of innovations is dependent upon "the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters. An idea that is incompatible with the values and norms of a social system will not be adopted as rapidly as an innovation that is compatible." (p. 15). He refers to this condition as "compatibility". To Karl Polanyi the economy itself "consists of technology employed within a context of institutions. This context is one of dynamic interaction. Institutions mold technology and technology molds institutions" (Stanfield 1990, 203-4). Karl Marx also put technology at the centre of his economic analysis of history, especially the history of the industrial revolution in Europe. Rosenberg (1982) argues that the main reason behind "the fruitfulness of Marx's framework for the analysis of social change" was that "Marx was, himself, a careful student of technology." (p. 34). Indeed Marx was one of the early writers to acknowledge the paramount social consequences of technological change. He largely saw the material forces of production as technological and the relations of production as social:

> "Technology discloses man's mode of dealing with Nature, the process of production by which he sustains his life, and thereby also lays bare the mode of formation of his social relations, and of the mental conceptions that flow from them." (Marx 1887, 352)

From a general historical-materialist perspective, Marx (1977) suggests that changes in the material forces of production render changes in production relations. Marx's statement, in *The Poverty of Philosophy* (1847), that, "The Handmill gives you society with the feudal lord: the steam-mill, society with the industrial capitalist" captures his general approach to the topic of technology-institutional dynamics. This perspective is consistent with Polanyi's conclusion that the main difference between capitalism and contemporary socialism is how modern technology is instituted in society (1957). While Polanyi was more supportive of the argument that economic

and political institutions tend to precede technological shifts—i.e. social change precedes and determines technological change (1944), Marx reordered the two. For example, to Marx the introduction of the factory workplace was a result of the emergence of the steam engine.

All the arguments above converge on the notion that there is a dynamic interdependence between technology and institutions and that technologies require a level of social embeddedness to be functional and continuous. Technological change requires institutional support, which makes technological development a social challenge. A 1993 report on technology transfer by the Organization of Economic Co-operation and Development (OECD) asserted that "the capacity for managing technological change is basically societal in nature, that is, it must permeate through many public and private institutions, all levels of society and be absorbed into the general "culture" of a country." (p. 4).

Traditional vs. Modern Technologies

In developing societies, development processes find themselves entangled in conflicts between two technological paradigms—old and new (or traditional and modern). The first is often the creation of technology users themselves (Gamser 1988; Visvanathan 2004), while the second is often the creation of designated professionals in modern societies, namely engineers and scientists, who are often generally separate from the technology users. This divide between creators and users does not hold with traditional technologies (Gamser 1988; Roy 2002; Visvanathan 2004). In developing societies traditional and modern technologies have to coexist and sometimes compete. This divide poses a challenge for localizing technologies – i.e. making them technically functional and institutionally embedded at the local level – and may result in delays in adopting new technologies even if they are objectively more effective.

Old local technologies and techniques are often described as ‘traditional’ or indigenous technical knowledge (ITK). In the historical cases of ITK, the lines are blurry between what constitutes technology and what constitutes cultural institutions (i.e. technological embeddedness is well established). This can explain part of the challenge of technological change in developing societies. For example, while agricultural mechanization in Africa needs to find a way to either replace or coexist with traditional agricultural technologies that are already embedded in local socioeconomic institutions, ICTs do not have to deal with that complexity. ICTs do not face similar resistance to adoption, compared to agricultural mechanization, because they are not replacing any technology that is already embedded in local socioeconomic institutions. The difficulty of replacing an existing technology that performs the same function could be a reason for the slow adoption rate of new agricultural technologies. This line of argument generally asserts that existing social institutions could be significant barriers in technological change processes. The effects of cultural institutions on technology seem to only be highlighted when the case of technology diffusion or transfer fails, for several reasons (among which may happen to be the cultural unsuitability of the technology) (see, for example, Eisler 2002; Rogers 2003; Adeel et al. 2008; Dengu et al. 2006). When cases of technological change are reasonably successful (see, for example, Lekoko et al. 2012; Fidiel 2005; Gulrajani 2006; Gilbert 2009; Al-Ghafri 2008) there is little highlight on how accommodating the local values and beliefs were to making that technology adoption a success. When technology users who are adopting a new technology are in considerable agreement with the technological change, the cultural suitability is not given particular highlight. What the literature suggests is that people’s cultural institutions are relevant to the genuine participation of technology users in the technological change process.

Howes and Chambers (1979) synthesize expert opinions that conclude the need for strong cooperation between ITK and modern science in the quest for development. Lucena et al. (2010) and Lekoko et al. (2012) also highlight the essential need for this type of cooperation. Scott (1998) adds the concept of Métis to the literature of ITK, which generally means 'practical knowledge', and "denotes the knowledge that can come only from practical experience." (p.6). "Far from being rigid and monolithic, [Métis] is plastic, local and divergent." (p. 332). The lack of access to scientific methods, laboratories and writing, did not mean that communities that relied on Métis lacked reliable knowledge, but rather only meant that they documented their rich and "remarkably accurate" knowledge systems through oral traditions and apprenticeship institutions passed from generation to generation. Scott criticizes development theories adopted by modern state-sanctioned schemes that place large faith in modernization and modern products and services while dismissing the contribution of Métis from indigenous and native populations. However, Métis has its own pitfalls since it is not democratically distributed (i.e. passed through generations by means of direct apprenticeship that prefer kinship and exclusive leagues of artisans) and survives today by more isolation from the rest of the world instead of engagement. These pitfalls can be mitigated through cooperation with scientific methods (Scott 1998). In further support of Scott's critique, studies such as that in Adeel et al. (2008) and UNEP (2008) conclude that traditional water technology systems are not achieving their promised potential in contributing to technological development (and to climate change adaptation), due to two biases: 1) scarcity in scholarly research dedicated to evaluating and improving traditional systems, and 2) less favour by funding agencies (public or private) for research and development (R&D) projects that aim towards improving the status of traditional ITKs (or Métis). Thus, for technological development schemes it is quite important to prioritize which sectors demand

introducing new technologies and which sectors require more support and local upgrading for existing traditional technologies.

Development Priorities

When people get better at utilizing a technology they also often get better at realizing how they can improve it. Hence, learning and improving by practicing is an essential part of technological change. Rosenberg identifies a number of factors he calls ‘supply side problems’ that determine the rate of new technologies replacing old ones (1982). The first factor is the continuity of inventive activity. Rosenberg observes that diffusion of technologies tends to be relatively slow everywhere with wide variations in the degrees of acceptance of different inventions. If we consider the steam engine a primary invention, for example, we can observe many ‘secondary inventions’ that improved the steam engine over a considerable period of time (Rosenberg 1972). The second factor is the development of technical skills among users. For example, it takes time to get labour to adopt or perfect a new use. Only then it will be possible to demonstrate the extent of the quantitative and qualitative superiority of the new technology over the old one. The third factor is the journey from conceptual solutions to working machinery. With the institutional separation between modern science and R&D circles, on the one hand, and machinery making circles, on the other hand, it often happens that conceptual solutions take long periods of time to translate into working machinery. Other factors, like economic feasibility of mass production and connection with willing investors (public or private), play a part as well. The fourth factor is the importance of the enabling environment for supporting innovations (i.e. macro policies and resources). An example is the role of the Japanese government in fostering Japan’s automotive industry, starting early from reverse engineering American automobile engines, which grew to a prominent global leadership (Japan Automobile Manufacturers Association, nd). Hence,

successful technological development must be accompanied by a process of skill upgrade for both makers and users. This is one dimension of increasing technological capabilities.

Additionally, technology adoption stories may express themselves differently according to the technology sector and a society's priorities. Binswanger (1986) offers some insights on this issue through focusing on agricultural mechanization, and proposes generalizations about the multiple factors that influence transitions toward agricultural mechanization in different parts of the world (such as the US, Japan, Pakistan and Brazil). Three of the relevant highlights Binswanger presents apply to more than agricultural mechanization alone. The first highlight is on how the economy of land and labour endowments affects the priorities and pace of the process of shifting to agricultural mechanization. The second highlight is on the relation between machinery design and capital costs: "Machinery design adjusts to high capital costs by lack of convenience features, simplicity, and reduced durability" (p. 36). While the cost of energy is a very important factor in machinery use, the costs of capital and maintenance tend to be usually larger. If capital cost is relatively high, then the innovator/adopter of the technology will try to maximize profit by compromising convenience, simplicity and durability. This highlight may explain why countries with least developed infrastructure tend to produce simpler, and less durable, engineered machinery—i.e. to compensate for the huge capital costs resulting from weak infrastructure to support industrialization (e.g., transportation infrastructure, consistent electricity and water coverage, industrial safety standards, strong vocational education) (Zanello et al. 2016). The third highlight is related to the argument of the decentralized nature of technology innovation. To the question of 'where does technological innovation often take place?' Binswanger has a direct answer: "In the early phase of [agricultural] machinery

invention, subinvention[3] and adaptation are done almost exclusively by small manufacturers or workshops, working closely with farmers. Public sector research has contributed little to machinery development, but more to education" (p. 50). Also, in agreement with Rosenberg (1972), Binswanger adds that "Inventive work on a particular operation often precedes by decades the widespread use of machinery. It reaches a peak during the initial adoption cycle, when derivative invention, refinements, and adaptation to different environments are required." (p. 51). Learning from Binswanger's observations in agricultural mechanization, a country's context informs technological change patterns, and different patterns call for different priority areas of technological development. Selected technologies may be chosen and given more focus for localization.

In summary, technological change experiences in developing societies are mainly influenced by three conditions: technology-institutional dynamics, development priorities, and the dichotomy of 'traditional versus modern' in key technology sectors. Addressing technological development requires a way of addressing all these conditions together through a common approach or a framework.

Technological Change Models

The technological change literature proposes a number of models that explain the main features, movements and vehicles of technological change. Such models are not conclusive or universal but each model may work well in explaining certain cases. In other words, each model has its

[3] Perhaps what Binswanger refers to by 'subinvention' is the category of inventions that modify or change only parts of the one machine or unit rather than the whole machine. For example, the invention of the automatic transmission in automobiles, in the 1950s, was a subinvention in the sense that it did not change the automobile or the function of the transmission itself in it, but rather invented a new part that substituted an older one within the same machine. It is perhaps the same as how Rosenberg (1982) distinguishes between inventions and innovations. Other terms that could perhaps be used to describe subinventions are: upgrades, derivative inventions (a term Binswanger also used in the same manuscript), secondary inventions, or even innovations.

strengths and weaknesses. These models seek to draw general trajectories and mechanisms of technological change that integrate some of the multiple factors discussed above.

Demand-pull Model

The demand-pull model suggests that economic demands (not necessarily other forms of demand) and their transformation in response to different economic dynamics, are the main stimulus for new technological innovation and adoption (Dosi 1982). Studies that have been undertaken in support of this model show good evidence in some contexts. Ruttan (1997) narrates the story of a classic study, from the 1950s, of "the invention and diffusion and hybrid maize", which "demonstrated the role of demand in determining the timing and location of invention" (p. 1520). Another study, from the same era, of patents statistics of innovations multiple industries (railroads, agricultural machinery, paper and petroleum) "concluded that demand was more important in stimulating inventive activity than advances in the state of knowledge." (Ruttan 1997, 2520).

In the demand-pull model – which itself has many versions –R&D of new technologies, and improvements to existing ones, are induced by economic demand pressures, which include competition, increasing demands, and external or environmental shifts that change demand in the market from one direction to another. For instance, Arthur (1989) proposes that competition between technologies in the market renders an 'increasing return': "Complex technologies often display increasing returns to adoption in that the more they are adopted, the more experience is gained with them, and the more they are improved" (p. 116). Competition in the market also highlights competitive advantages of different versions of the same technology, which will then promote the improvement of technology to respond to the demands of adopters. According to

Arthur (1989) sometimes earlier access to some markets may determine the course of technological domination.

This model is not particular to developing societies, of course, but its implication in development studies is that to stimulate technological development it is necessary to stimulate local economic demand. This suggests that promoting technological change can largely happen through market incentives and regulations. This model says little about where the technology comes from (i.e. local or imported) and how sustainable that is. Places like the oil-rich Middle-Eastern countries can be said to be technologically advanced from this perspective, while it is evident that there are big deficiencies in terms of national technology and science education and innovation in these countries (Pink 2009; Shaw 2002). In such cases the technologies have not been really localized, and the countries' own technological capabilities cannot be said to have improved proportionately over time. The demand-pull model also seems to take human creativity for granted. It provides no clues as to how to nourish and support innovative talents within developing countries to advance technologically. Furthermore, this model suggests that where economic demand stabilizes, or competition is non-existent, technological change will likely stall. This suggestion would be challenged by a body of historical economic studies of pre-modern-capitalist, and older societies across the globe, where market forces did not seem to have contributed decisively to the many advancements – or regressions – that happened in technology and innovation (see for example, Polanyi et al. 1957). A number of modern technology breakthroughs were a result of the material and ideational sponsorship of the state's public sector without the initial triggering of demand, such as computer numerical control (CNC) machining (manufacturing automation) in the United States (Noble 1987). For one extreme example, it was through the efforts of the state, without clearly expressed economic demand, that the USSR took

its society through a mammoth technological change process that, in a few decades, transformed it from a largely agrarian economy to launching the first artificial earth satellite and sending the first human into outer space. Rosenberg (1982) also gives an example of the technical change that happened in the commercial aircraft industry in the USA over the fifty years period between 1925 and 1975. While it is by many measures a very successful story of rapid technological advancement, productivity and economic growth, the role of the federal government was the most important factor. Generally governments of industrialized economies fund science and technology R&D generously through military and civilian research, and much of that funding renders technological breakthroughs that later 'trickle down' to the civilian markets (both national and global) (Mazzucato 2013), but these breakthroughs are not necessarily triggered by existing economic demands. Evidently the demand-pull model works quite well in many cases but not all.

Technology-push model

In the technology push model, technological change is instigated by innovative talents of individuals and teams. This model has a number of characteristics. First, there is the increasing connectedness between objective, non-market driven, scientific inquiry and technology innovation processes. Second, there is "the increased complexity of R&D activities which makes the innovative process a matter of long-run planning" (Dosi 1982, 151), for private and public organizations, which further distances the innovative process from direct market response. Third, while there is clear correlation between R&D efforts and "innovative output" (which can be measured by the patent activity, for example), there is not a similar clear correlation between market demands and the same measures of innovative output. Finally, as processes that seek to unfold what is not yet known, innovative processes are naturally surrounded by uncertainty (i.e.

whether the R&D process, or scientific inquiry, is going to find solutions to the posed problems or not, or not-yet, etc.).

The technology-push model can explain how, for example, Singapore's massive investment in technology and science education helped transform it, in a few decades, from a poor country to a technologically advanced one (Patterson & Bozeman 1999). This model can also explain better the path of the Japanese Toyota company that made leaps in automotive engineering until it became a world leader in the manufacturing field with the Toyota Production System (TPS) (Monden 1993). The development policy implications of this model focus on innovative talents. It is important to invest in building and sustaining the proper institutions for nourishing technology and science and encouraging innovation. Yet, the shortcomings of this model seem to be the same advantages of the demand-pull model. At some point, innovative processes must be connected to the larger economic cycle to diffuse in society. The technology-push model says very little on this aspect.

Path-dependence model

This model cites a number of historical case studies to emphasize how technological change is built up with every step dependent on the steps taken before it. The model explains historical developments. It also suggests that innovative talents and economic incentives are sometimes not able to save technologies from locked-in trajectories. Path-dependence can be illustrated by the case of the QWERTY keyboard (a descendent of the QWERTY typewriter). Rogers (2003; 8-10) gives a good historical account of how a more efficient typewriter (the Dvorak) is being ignored by the vast majority of computer users today due to a series of historic events that brought the QWERTY typewriter only as a temporary solution to reduce the speed of typing (and thus reduce the number of mistakes printed). The evolution of the computer keyboard was locked into a

system of path-dependence inherited from the slower keyboard layout. Today we do not need to worry about slowing down our typing speed for the sake of printing fewer mistakes, because we type on word processors and correct mistakes before printing to paper (and we may not even print at all). But still the majority of computer users around the world use the QWERTY keyboard and not the faster Dvorak. Ruttan (1997) also mentions the QWERTY case, and says that this particular case has attained the status of "a founding myth" in the path-dependence literature.

Rosenberg's observations (1972) also give credit to the path-dependence model. Rosenberg argues that most technological innovations appear incrementally, diffuse incrementally, and depend on many external factors in the process.[4] He then presents a historical review of some of the outstanding technological changes that define our industrial times, such as the steam engine (which was patented in 1781 by James Watt):

> "Steam did not begin to play an important role in powering the British economy until the 1830s and 1840s, and was not massively applied until the 1870s and 80s. Even as late as the 1870s less than a million horsepower was generated by steam in the factories and workshops of Great Britain." (Habakkuk 1962, quoted in Rosenberg 1972, 5).

Rosenberg also follows the incremental improvements of the steam engine, and how they needed other inventions to appear before they took place (such as the invention of more accurate-measure cylinders that helped James Watt decrease significant loss of steam from his engine). There is also a learning curve of technology improvement that takes years, if not decades. During this time many events and incremental changes accumulate, without which the final product – if there is ever such a thing – does not stand. Furthermore, the early versions of any technological

[4] While the point Rosenberg is making – the incremental nature of technological improvement – is not necessarily the same as path-dependence, they two are evidently related.

innovation tend to change dramatically over time due to these incremental changes, often contributed by various sources.

Table 1 Summary of explanatory models of technological change			
Model	**Main Claim**	**Implication**	**Blind Spots**
Demand-pull	The nature of market demands, and their transformation in response to different economic dynamics, are the main stimulator for new technological innovation and adoption.	Promoting technological change needs to happen indirectly though stimulating the market, by inducing market incentives and regulations.	- Obscures the role of innovative talents. - Says little about the substance of science and technology R&D processes. - Does not account for the inherent uncertainty in the R&D inquiry process.
Technology-push	Technological change is autonomous, or quasi-autonomous, of market mechanism, has its own dynamics, and is highly instigated by innovative talents.	Investment in building and sustaining the right institutions for nourishing science and technology and encouraging innovation.	- Fails to account for the importance of economic conditions (institutions, resources, demand, etc.) to complete the technological change cycle.
Path-dependence	Technological change is an incremental process that is path-dependent. New innovations build on the previous prevalent products and techniques (which are not necessary the best ones, but happened to be prevalent due to other social, economic, or peculiar circumstances).	Policy implications of this model are unclear. It helps explain the evolution of many forms of products and techniques, but does not quite indicate what development policy can use from the model.	- May cover a good range of technologies, but not all of them. - Policy implications are less lucid.

Multiple writers argue that the three models above are not sufficient – especially without integration – in explaining technological change in its generality (see Table 1). Ruttan (1997) argues that the three models represent elements of a general theory that has not yet been invented. However, the likelihood that such a theory could be found is small and detracts from the more useful effort to understand the diverse mechanisms or factors that contribute to technological change. Each of the models reviewed above describes some mechanisms and factors. It is thus sufficient to see them as part of a larger framework that encompasses and

connects them and adds to them. The models above, for example, do not take into account cultural resistance to new technologies (i.e. embeddedness).

Other scholars attempt to explain technological change processes more broadly. Dosi (1982) proposes the more general concepts of 'technological paradigms' and 'technology trajectories'. Technological paradigms are uniform patterns of solutions offered to sets of technological problems, “based on selected principles derived from natural sciences and on selected material technologies.” (p. 152). A typical technological paradigm would include a basic set of prescriptions to follow when addressing a certain ‘cluster of technologies’ (e.g. agricultural technology, transportation technology, energy technology, etc.). Technology trajectories are the 'normal', cumulative progress within the same technological paradigm (a continuity). A shift to a substantially different way of innovation represents a 'discontinuity' of the paradigm, hence a new technological paradigm. People following a certain technological paradigm can excel in finding and implementing similar solutions to familiar problems, but they also tend to exclude different imagined possibilities, as solutions, in favour of normal – or normalized – expectations within the paradigm. New paradigms can emerge with dramatic breakthroughs, either due to innovative talents or institutional transformations (e.g. the emergence of the steam engine, or the personal computer). A technology trajectory can also change if significant changes happen in the same cluster of technologies, but without causing a change in the main principles of the technological paradigm. An example for this change in trajectory – but not paradigm – is the introduction in the 1950s to automatic transmissions in automobiles. Dosi’s model of technological paradigms may prove useful in explaining some historical events, but does not seem quite capable in explaining contemporary processes of technological change in developing societies. For example, the technological divide that may exist inside the same developing

country – between modern and traditional technologies, or urban and rural communities – is among development challenges that are difficult for this framework to explain. In a developing country, such contradictions may look as if they are somehow all embedded, as far as this framework is concerned, but the status of technological dependency and its consequences on human development, are not flagged. Generally, Dosi's model explains changes in individual technologies but not the general movement of countries along the path of increased technological capacity or technological autonomy.

In summary, we can conclude that in order to describe what an effective technological change process would be for developing societies, the models of technological change are not sufficiently broad. They offer points of guidance but need to be put together in a framework that provides a more coherent understanding of the objectives and challenges of national or sectoral technological development. In particular, a framework is required that identifies how technologies are localized by a developing society and technological autonomy created.

CONCEPTUAL FRAMEWORK: TECHNOLOGICAL AUTONOMY

Technological autonomy refers to a society's attainment of a sufficient level of endogenous capacity for generating, transferring and adapting technologies, guiding industrialization and innovation, and setting technological development priorities in order to achieve self-determination in planning and managing its technological affairs. The concept of technological autonomy has not been widely discussed in the technological change or development literature, but Morehouse (1979) referred to it as a goal for developing countries:

> "Development strategies, relying on importation of capital-intensive, socially inappropriate, environmentally destructive Western technologies… have been at the heart of the accelerating de-industrialization of the Third World… While we cannot be certain that greater autonomy will lead to greater equity, few Southern countries can go very far in meeting the minimum material needs of most, not to speak all, of their people without

> a greatly strengthened autonomous capacity for creating, acquiring, adapting and using technology to solve their own urgent economic and social problems." (p. 387)

Morehouse later adds that, "technological autonomy is not, of course, autarky, but it does imply greater selectivity in, and closer control of, externally acquired technology" (1979, 397). Technological autonomy is reached when self-determination of technological affairs is attained. This requires both increased technological capabilities and technology localization. Elaboration and integration of these key concepts is below.

Technological dependency and autonomy

To develop the concept of technological autonomy we can begin by looking at its opposite: the state of technological dependency. During the 1960s and 70s many 'third world countries' sought to negotiate terms of technology transfer with 'first world countries' and transnational corporations, through UNCTAD (The United Nations Conference on Trade and Development), NIEO (New International Economic Order),[5] and other multilateral organizations and frameworks. That experience was summarised by Haug (1992):

> "The third world's frantic attitude toward technology transfer resulted in the countries falling victim to a sort of "technological colonialism." Taking advantage of the third world's desperation, TNCs [Transnational Corporations] drew-up largely one-sided transfer agreements. For example these agreements often linked the transfer of technology to the right to build, operate, and maintain the manufacturing plants. Suffering from a lack of information about the technology and about the transfer process, many third world nations accepted these agreements. Consequently little technology was actually transferred to the developing countries, and those countries failed to develop an indigenous technological capacity." (Haug 1992, 218)

Haug (1992) lists a number of problems that made developing countries vulnerable to such 'technological colonialism': lack of reliable infrastructure conducive to optimal technology

[5] NIEO: a program of action that was approved in 1974 by UN General Assembly, which was "intended to eliminate the economic dependence of developing countries, promote their accelerated development based on the principle of self-reliance, and introduce appropriate institutional changes for the global management of world resources." (Haug 1992, 219).

utilization, failure to develop local technological skills, import of inappropriate technologies for local contexts due to insufficiency of information and knowledge, and absence of technological development plans (i.e. institutional and policy immaturity).

Desai et al. (2002) argue that "Not all countries need to be on the cutting edge of global technological advance, but every country needs the capacity to understand and adapt global technologies for local needs." (p. 97). Anything below that capacity can be described as a situation of technological dependency. Desai et al. argue that many developing countries today are in that situation. Lall (1992, 182-82) also says:

> "Technological development always needs technology imports from advanced countries. The extent of dependence on imported technology and the form that technology imports take, however, affect NTC [National Technological Capabilities] development. A passive reliance on foreign skills, knowledge and technology may lead to NTC stagnation at a low level, while selective inputs of foreign technology into an active domestic process of technology development can lead to dynamic NTC growth."

Therefore, technological autonomy does not mean that a society is self-sufficient in technological products and services, without having to engage with the rest of the world. In this age of globalization, self-sufficiency is extremely difficult and, more importantly, gives no particular advantage. The technology supply chain and global market give no advantage to self-sufficiency, but to technological autonomy. "Autonomy" implies the ability to engage the rest the world in the exchange of technological products and services with a level of agency that does not make the society a helpless receiver of technology, without power to choose, negotiate, and have a degree of technological sovereignty.

Proposed Technological Autonomy Framework

Technological autonomy refers to the attainment of a sufficient level of self-determination of technological affairs for the given society. A "sufficient level" implies that there is endogenous

capacity for making and executing decisions on guiding innovation, industries, technology transfer, and priorities for development. For example, a country can be technologically autonomous when its food security and basic infrastructure (housing, utilities, transportation, and basic telecommunication networks) are not threatened by supplier countries. On the basic services of education and healthcare, technological autonomy means the capacity to build and reproduce technological knowledge and skills of the local population, and to foster their innovative talents, in an environment that also meets basic health and safety requirements, without being particularly dependent on external powers as suppliers of those basic services.

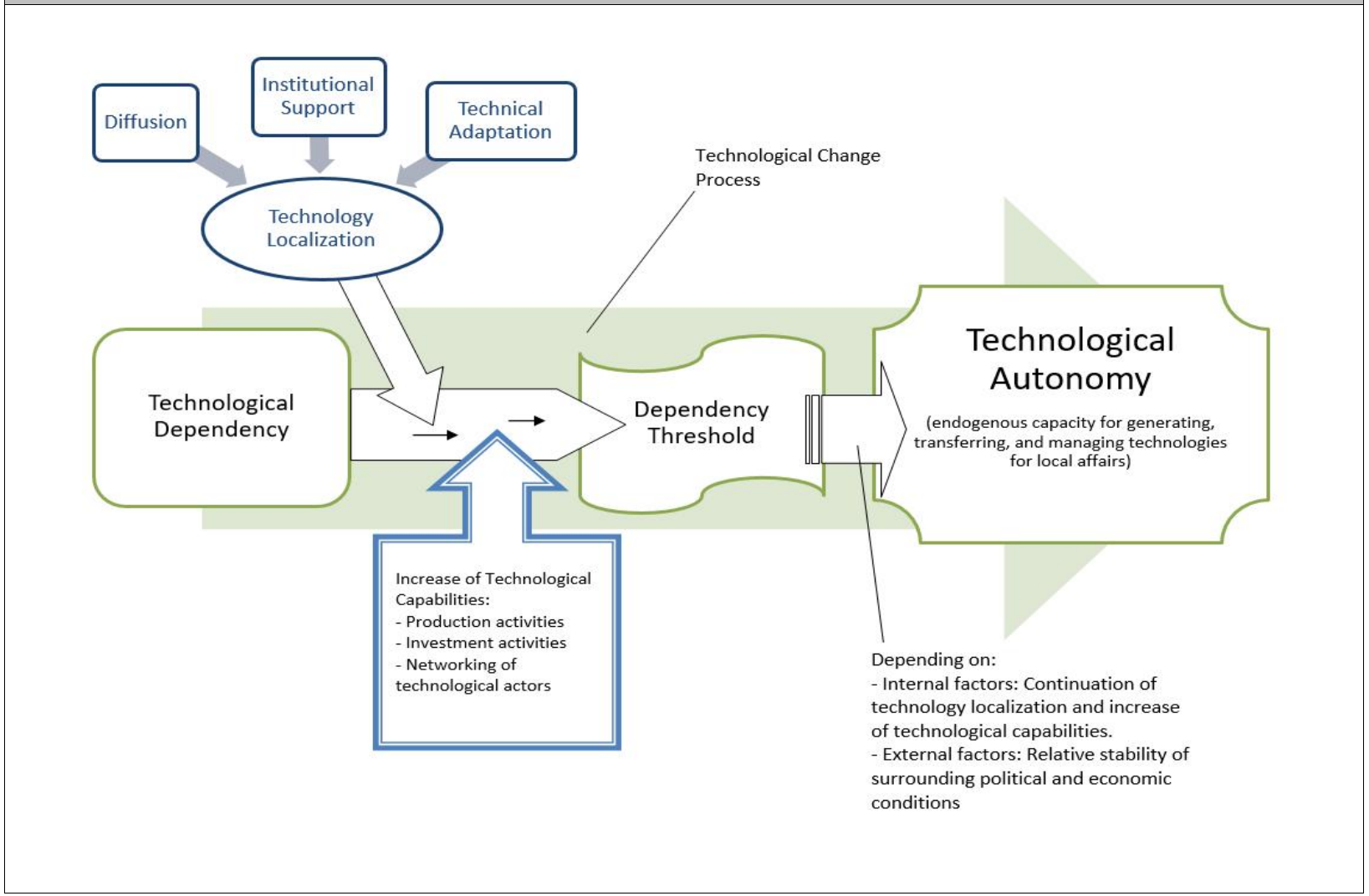
The framework provided below identifies a set of concepts and relationships that can be used to build theories and explanations about technological autonomy. Following Ostrom's (2005) criteria of a conceptual framework, it is comprehensive enough to address the general problem of technological autonomy and flexible enough to allow for the creation of multiple models and policy strategies, depending on the context, to achieve a broad goal. The technological autonomy framework can support the development of explanations for technological change processes, guide research on technological change, and contribute to policy formation. Additionally, the specification of the main variables of technology localization (diffusion, institutional support and adaptation) is useful in identifying research gaps and in mapping and selecting policies that suit various organizational, social, and jurisdictional contexts.

By highlighting the elements in technological change processes, the framework is intended to guide areas of focus for research as well as support informed decision-making. The main features of the framework are shown in Figure 1. It shows a technological change process leading to the achievement of a basic level of technological autonomy—i.e. to abate

technological dependency. The main variables of that process are the internal factors of (a) technology localization, and (b) technological capabilities. While technological capabilities relate to the general enabling environment for productive in society, technology localization addresses chosen technologies of particular importance and priority in specific local contexts.

Different developing societies manifest different levels of technological dependency, as could be determined from their state of technological affairs. Moreover, their various contexts will determine various policy and structural planning and implementation priorities, based on their relative sets of assets and vulnerabilities. Therefore, different levels of technology localization and technological capabilities are expected (figure 1). A developing society (country, region, community, etc.) can be located at any point on the continuum leading towards technological autonomy at any particular point in time, and can be moving forward (or backwards) on that spectrum. Technological development implies moving forward on that spectrum towards technological autonomy.

Figure 1 Framework of technological autonomy



The dependency threshold in the framework (Figure 1) suggests that if a society is beginning to free itself from the limitations of technological dependency and move towards technological autonomy, then we can say that that society is at a dependency threshold. This threshold state is made possible by internal and external factors that, together, can lead a society towards technological autonomy. The internal factors, are represented by the activities of technology localization and the increase of technological capabilities (production activities, investment activities, and networks of technological actors). The external factors are represented by an assumption of relative political and economic stability. External forces have an influence on any process of technological change, even if the internal factors are optimal. However, the scope of the external factors is beyond the reach of this thesis. Reference to them in the framework was important so as not to suggest that only internal factors play a role in the creation of technological autonomy.

Increase of Technological Capabilities

Technological capabilities refer to the "dynamic resources which encompass the skills, knowledge and routines involved in generating and managing technological change, whether they concern production activities, investment activities, or relations with other [technological actors]" (Albu 1997, quoted in Gulrajani 2006, 154). Thus, the activities for increasing technological capabilities fall into three categories: production activities, investment activities, and the networking of technological actors (Figure 1). Production activities include the integration of skilled labour and natural resources in making and utilizing technologies. Investment activities concern decisions and actions in channeling finite resources into enhancing technological sectors by increasing human resources, accessing natural resources, or R&D endeavors. Networking of technological actors refers to the interactions and communication

between producers, investors and innovators that coordinate their work and pursuits. Networks are known to be generally more productive and efficient than isolated or fragmented groups of actors. In other words, technological capabilities address the general enabling environment for technologically productive forces in a society. The technological change literature demonstrates that effective technological change experiences, by and large, have been the outcome of multiple actors and institutions building upon each other's work (see for example Rosenberg 1972; 1982; Binswanger 1986; OECD 1993; Nasir et al. 2011).

The concept of technological capabilities was introduced by Lall (1992) and Gulrajani (2006) in the context of industrial clusters but was later enhanced and applied to firms as well as to national systems. Lall (1992) takes technological capabilities from the firm and industrial cluster level to the national level. Lall suggests a 'simple framework' for explaining national technological change planning includes: policies of market incentives (micro and macro), increasing technological capabilities, and institutions. By incentives Lall refers to the policy and market stimulants that encourage investment in innovative endeavors, on-the-job training and business environment improvement. By institutions Lall refers to the national bodies that plan and execute interventions, and regulate constraints, to induce economic, social and innovative factors to work together in investing in human and physical capital.[6] A similar conclusion is reached by others who examined the stories of industrial development in Asian Newly Industrializing Economies (NIEs) (e.g. South Korea, Taiwan, Brazil, South Africa, India, and Malaysia) (See Kim & Nelson's (2000) edited volume).

[6] Note: the definition of institutions by Lall (1992) is not the same as the definition adopted by this paper. Lall's definition is particularly limited to national formal institutions.

These stories of NIEs can be viewed as stories of transformation from technological dependency to technological autonomy. Yet the framework that Lall suggests does not address issues of diffusion and technical adaptation, particularly at the level of users and smaller social units within the national umbrella (such as rural communities). Additionally Lall's framework does not sufficiently address two of the conditions that technological development faces in developing societies: the dichotomy of modern and traditional technologies and the context-determined priorities of development (which can seriously influence the trajectory of technological change in a given society). Such issues have a record of causing resistance to technological change among targeted communities in developing societies. The framework of technological autonomy addresses these issues through the variable of technology localization.

Technology Localization

While the increase of technological capabilities represents the strategic, continuous and cumulative side of a technological change process, technology localization represents the interventionist side of the process. It is meant to respond to incidents where there are persistent elements of resistance to change regarding particular technology types. For a variety of reasons, some technology types suffer persistent low levels of adoption over time in developing societies (e.g., agricultural technologies in sub-Saharan Africa in the last 3 decades) while others do not (e.g., ICTs in sub-Saharan Africa during the last decade). In cases of resistance focused interventions may be required. Technology localization refers to activities that seek to make chosen technologies locally functional and locally embedded (i.e. without high resistance). Such technologies are typically of particular importance and priority in specific contexts. The main activities of technology localization are:

1- Diffusion; which refers to persuading the concerned segments of society, through communication and promotion, to adopt new technological innovations.

2- Institutional support; which includes policy advocacy, resource mobilization (e.g. finance and credit systems), and logistical and training assistance for the operationalization of chosen technologies.

3- Technical adaptation; which includes additional, incremental, technical modifications to the technologies of concern, or complementing technologies in ways that add value and increase usability of the technologies in specific contexts.

In brief, local technological change requires diffusion of new technologies, support for the technologies' operationalization, and sometimes adaptations of available technologies to fit more effectively into a local context. The three processes are mutually supporting. Technology localization, if successful, increases technological change and increases technological capabilities. To explain the contribution of technology localization to technological autonomy, we first have to look at the nature of the life cycle of technological innovations. Understanding that life cycle – from inception to maturity to diffusion and adoption – allows us to recognize the value of the role played by diffusion, institutional support and adaptation in promoting technological change.

Innovations emerge out of conditions where different objective and subjective elements come together in particular historical contexts. Those contexts present incentives and constraints that are sometimes institutional (formal or informal) and sometimes environmental (i.e. ecological, geographical, etc.) (Rogers 2003; Hodgson 2004). Most innovations in history occur in decentralized settings where smaller groups or individuals share the credit for the innovation (Binswanger 1986; Rosenberg 1972). Even when macro planning is involved, it manifests in giving latitude, mission and resources to particular small groups, such as engineers, scientists, technologists and artisans (and their historical equivalents) to undertake innovative projects (Noble 1984). Innovation tends to be carried out in smaller entities in society, such as firms,

laboratories, and specialized teams/associations (such as artisans and technicians). Even within those smaller entities, it is common to find even smaller teams (or individuals) as the initiators and custodians of new technological products and systems.

It is critical to distinguish between innovation, on the one hand, and innovation diffusion on the other hand. Innovation involves learning from conditions and environments, conceptualizing solutions, and providing material demonstrations of those solutions. Diffusion of innovation, which comes after the realization of the innovation, is "the process by which an innovation is communicated through certain channels over time among the members of a social system… The diffusion process typically involves both mass media and interpersonal communication channels." (Rogers et al. 2009, 418). Rosenberg (1972;1982) and Binswanger (1986) document that, generally, new technologies require a considerable amount of time between their first incubation and the time when they show a visible level of adoption. Noble (1984) and Kreszner (1987) also document the time it took private manufacturing firms in the USA to adopt Computer Numerical Control (CNC) machining from the time the technology was ready for adoption. Technology localization refers to the activities that take place in the period between the discovery of a technological innovation and the time it becomes widely adopted in society. The activities of technology localization can occur at macro as well as micro levels (see table 2). Diffusion is thus one element in localization.

The other activities of localization are institutional support and technical adaptation. Institutional support addresses the need with some technologies to have support with advocacy, resources, training and logistics as they gradually permeate society and become integrated. Technical adaptation addresses the required alterations to technologies adopted from other societies to make them more compatible, in functional and sustainable terms, with the new local

context. Table 2 lays out a variety of sample technology localization activities at national levels, organizational levels and between. Each level has corresponding sample activities of technology diffusion, institutional support and technical adaptation.

While innovation has a decentralized nature, localization is a collective process. It needs more collective work because it addresses a challenge of collective nature, that is to make a technology adopted and effective in a particular society. Developing societies face critical challenges in achieving technology localization.

Table 2 Technology localization matrix (sample activities)

	Diffusion	**Institutional Support**	**Technical adaptation**
National level	- Promotion of hands-on training and applied research in educational institutes, etc. - Establishment of national innovation systems.	- Infrastructure building (e.g. transportation, power and water, etc.) - Policy incentives and constraints - Local innovation-friendly taxation systems	- Provision of counseling and access to R&D information resources to organizations and communal initiatives - For critical development sectors, establish national R&D institutions
Communal/social level (municipalities, villages, civil society)	- Use of mass media to communicate new technological solutions and highlight challenges to stir ideas - Promotion of innovative solutions through media local funding (municipalities, etc.)	- Schools to have embedded curricula of technological orientation (i.e. innovative problem-solving projects drawn from the surrounding environment, etc.) - Worker associations to hold technological education seasonal workshops, etc.	- Community initiatives such as local competitions and awards for 'best innovations' for certain local challenges - Technology incubators and innovation centers
Organizational level (firms, social enterprises, NGOs, etc.)	- Adopting organizational systems that are innovation-friendly and employee-empowering (such the Toyota Production System)	- Resource allocation for R&D teams; - Positive risk and opportunity assessment; etc.	- Apprenticeship programs; skills-upgrade courses; reverse engineering projects; etc.

Agents of Technological Change

The framework and the variables, described above, are made operational by agents of technological change. These agents are not ‘in’ the framework because they are not ‘variables’ in it; rather they are the ones that operationalize the variables. At communal, social, national and regional levels, these agents are seldom individuals. They represent groups, associations and bodies, even when they act sometimes and in some respects as individuals. Different contexts require different agents of change. There are a variety of agents, established or emerging, at various levels of engagement in stimulating and actualizing technological change, such as national innovation institutions, educational institutes, technical training and R&D establishments, manufacturing and design firms, technology incubators, NGOs, and social enterprises.

In the technological change literature, much is studied about the role of the state (public/national sector) and private firms (private sector), including any range of combination of the two, such as public-private partnership programs, parastatal corporations, and transnational corporations with some public-sector shares. In varying degrees, the state and the private sector are active in industrialized, semi-industrialized and low-income countries. In developing societies there is no evidence that any genuine measures of technological development have been achieved under weak or non-developmental states (see Nyerere 1998, Kim & Nelson 2000 and Nasir et al. 2011). For example, Kim & Nelson (2000) show that in the newly-industrializing economies (NIEs) developmental states mobilized national industrialization plans utilizing the state apparatus and resources as a key agent of technological change. The state can furnish the enabling environment for industrialization, provide resources, and support the growth of key or

immature industries. It can also support human capital formation and innovative technological R&D thus encouraging continuing growth in general or in particular sectors (see for example, Noble 1984; Kroszner 1987; Wolff 1999; Ash et al. 2006; Mazzucato 2013). On the other hand, the private sector, under conducive conditions, can champion significant R&D activities that can lead to improving products, processes and services (see for example, Arthur 1989; Monden 1993; Rogers 2003).

Yet, in developing societies, there are technological development challenges that neither the public sector nor the private sector have been successful in meeting. Under such conditions, new agents of technological change sometimes fill gaps left by the old agents. For example, in rural regions of developing countries neither the state nor the private sector have made significant advancements in technological change, particularly in key sectors such as agriculture, agro-processing, energy generation and distribution, water supply, sanitation, and transportation. Recently in these sectors a number of social enterprises have begun to emerge, diffusing new technological products and services to communities. As emerging agents of technological change in developing societies, they have not yet been studied in that capacity.

SOCIAL ENTERPRISES AS AGENTS OF CHANGE

Social enterprises are considered part of 'the third sector', which includes NGOs, civil society organizations, as well as many cooperatives. The entire array of social enterprises that are growing in number and form in developing societies should draw keen interest from analysts of technological change. A social enterprise has been defined as "a business with primarily social objectives whose surpluses are principally reinvested for that purpose in the business or in the community, rather than being driven by the need to maximize profit for shareholders and owners." (UK Department of Trade and Industry 2002, 7). It has also been defined as "a social

initiative that addresses social needs or catalyzes social transformation. The creation of social value is the primary objective of the venture, while economic value creation represents a necessary but not sufficient condition" (Mair & Schoen 2007, 55). Social enterprises cross the boundaries between the conventional private sector and the voluntary or philanthropic sector, along with carrying some 'public sector principles' of democratic/participatory management and equitable redistribution, for the sake of human and/or environmental well-being (Ridley-Duff & Bull 2011). They include some cooperative models, credit unions, micro-finance banks, fair trade businesses, some business incubators, NGOs with a focus on economic activities, businesses with profit-sharing schemes with their communities, and other organizations with similar approaches (Alter 2007; Haugh 2012). The social enterprise concept, and recent models, appeared in Western Europe and Northern America with the aim of filling a gap in the socioeconomic fabric which neither the public sector, nor the private sector, nor conventional NGOs could quite fill. The term itself refers to a host of business models, some of which are new, but some are older than the term itself, such as cooperatives, the fair trade movement, and some microfinance initiatives and credit unions (Alter 2007; Desta 2010). SEs in Western Europe and Northern America have attracted attention as a relatively new channel for expressing and realizing innovative responses to socioeconomic challenges of local communities.

However, since some of them are new forms of organization, with a relatively new way of looking at problems, social enterprises face many challenges related to defining their territory and standardizing their areas of work. Some of these challenges may explain why a social enterprise model would work in one social context and not in another. Another challenge is related to the degrees of consistency, or dissonance, between theory and practice. Most scholars of social enterprise and social entrepreneurship agree that a precise and unified definition has not

yet been reached (Lautermann 2013; Haugh 2012; Pattie & Morley 2008; Dart 2004; Alvord 2004). After “a profusion of definitions found in the first decade of the twenty-first century,” scholars began to move towards building general consensus on the general characteristics of social enterprises instead of articulating a universal definition for them (Haugh 2012, 9). The current general claim is that social enterprises are basically business ventures who have more emphasis on creating ‘social value’ than the ‘conventional’ businesses (i.e. for-profit private businesses), but we are still left with the ambiguities of measuring social value and its creation in the entrepreneurship circles (Lautermann 2013). Nevertheless, it is safe to say that, as Pattie and Morley put it (2008), social enterprise is “a form of business that is distinctly different to conventional commercial enterprise.” (p. 91).

As is the case with some other fields of study, social enterprise theory appeared after the practice itself and sought to catch up with it. Generally, in theory social enterprises broadly promote products and services that adhere to triple bottom line values (social, economic, environmental) (Haugh 2012). In practice, they represent organizations that cross the conventional boundaries between for-profit businesses and voluntary or philanthropic missions, along with borrowing some ‘public sector principles’ of democratic representation and equitable redistribution, all for the sake of human and environmental well-being (Ridley-Duff & Bull 2011). In summary, social enterprises include:

- Credit unions, revolving funds, micro-finance banks, or similar organizations which use financial business models to promote social and/or environmental goals (Henderson and Vercseg 2010; Yunus 2008; Alter 2007).

- Cooperatives and social firms which apply democratic approaches to sharing surplus and human resource management (Dacanay 2012; Rodgers 2008; Brookfield et al. 2003; Lim, Yap & Devlin, 2015). Instead of the typical market economy model of ‘capital hires labour’ for generating profit, these organizations work on the principles of ‘labour hires capital’ for purposes determined by labour (Spreckley 1981).

- NGOs that use business models to promote economic practices for developmental or environmental benefits, and/or NGOs with revenue-generating activities to self-support their programs and projects (Willams et al. 2011).

- Private businesses that have significant, above average emphasis on ventures for development, social innovation, and/or sharing surpluses for the public interest, such as sustainability and sustainable development, fair trade, equitable employment, etc. (Amm 2009; Alter 2007).

Social Enterprises and Technology Localization

Recently, social enterprise models in developing societies have come to replace some of the more traditional NGO work with respect to technology diffusion (See for example Amm 2009 and Rensburg et al. 2008). Although the social enterprise literature has been growing over at least two decades, the study of the success of social enterprises as agents of technological change has only begun to be explored. For example, van der Horst (2008) presents an account of social enterprises being potential leaders for diffusing renewable energy technologies in the UK. Williams et al. (2011) cite the case of Just Energy as an emerging social enterprise model with potential for diffusing renewable energy in rural South Africa. Buell & Mayne (2011) explore low-carbon initiatives that take social equity as a main aspect, from South Africa, the UK, and the USA, with the argument that business approaches with moral/social imperatives are well-equipped to thrive as sustainable and preferable models. Due to their orientation towards both social value and commercial value we could expect that social enterprises would be found active in contexts where there are social barriers to technological innovation because innovative products – e.g. technologies and/or systems – create social value but can also often be commercialized in socially responsible ways.

Through their inclination to support decentralized and context-based solutions, social enterprises have the potential to be effective promoters of transformative technologies and innovations. Social enterprises that are attuned to the difficult balance of business rigor on the

one hand, and social altruism and innovation on the other hand, are also likely to be capable of diffusing new solutions that cause shifts in the usual livelihood activities and crafts. Overall, social enterprises are not restricted to one way or another of interacting with technology or innovation for social value creation. They may innovate their own products or services, market already-existing products for new contexts, or adopt and upscale local or endogenous solutions (Rogers 2003; United Nations Convention on Biological Diversity 2007). They can be agents influencing multiple variables (and sub-variables) of technological change.

Social enterprises are suitable to play an effective role in technology localization because: 1) technology localization activities that are undertaken by the public sector can be hindered by bureaucratic channels and social enterprises are not so constrained; and 2) technology localization may not render immediate monitory rewards, and as a form of business investment with many risks of un-redeemable costs – especially in developing societies – it makes technology localization unappealing for the majority of the private sector. Social enterprises have the potential of being free from these constraints of both public and private sectors. In numerous technology localization activities, there needs to be some social imperatives, beyond profit-making, that encourage organizations to take calculated risks for engaging in technology localization—and that is the element social enterprises may have in comparison to the typical private sector organizations. On the other hand, many technology localization activities appear to require flexibility in approach as well as timely responses and seizure of opportunities—a dynamism that the bureaucratic machinery of the public sector may not be able to accommodate. These could be reasons for the recent relative increase of social enterprise activities in developing societies. But have social enterprises proven to be successful agents of technology localization in developing societies? This thesis investigates that possibility.

Social Enterprises in Developing Societies

The social enterprise literature has already begun to diversify its perspectives according to geographical and geopolitical contexts (i.e. different societies, different rules), since social enterprises cannot avoid being influenced by the institutional environment, cultural context, economic constraints, and technological infrastructures of their locations. For example, the environments of Western Europe and North America, where the social entrepreneurship concept was first realized and initiated, are characterized by an established infrastructure, industrialization and key public services. Social enterprises then filled in areas of socioeconomic development for vulnerable communities in that context where the state's presence receded and the private sector was yet unaffordable. In developing countries, the context is different, and social enterprises have to modify their missions and goals to be relevant. For example, the socioeconomic needs of rural communities in East Africa, where agriculture still relies on traditional technologies, and the infrastructure of energy, water and sanitation is minimal, will be essentially different from those of rural communities in Western Europe.

Currently, the social enterprise literature generally supports the claim that Europe is where social enterprises are most diversified, abundant, legally acknowledged, scholarly studied, and generating value (Granados et al. 2011; Palmas 2012; Dees 2007; Defourny and Nyssens 2008). Studies about social enterprises in other parts of the world have been growing recently, covering Japan (Larata, Kakagawa and Sakurai 2011; Nakagawa and Laratta 2010), China (Jiao 2011; Yu 2011), and even indigenous communities in Northern America (Anderson, Dana and Dana 2006). As for studies of social enterprises in developing countries, and besides the usual mention of Bangladesh' Grameen Bank, they are yet minimal. For example, Ramtese and Shah (2012) provide case studies of two social enterprises in India: Gram Vikas and Aravind Eye

Care, which took on the causes of better access to drinking water and sanitation and better access to eye care in rural communities. Gram Vikas, for example, established community-run water supply and sanitation systems that are financed by community household contributions. The case of Gram Vikas is an example of a social enterprise with technology localization activities (particularly diffusion). The Sorosoro Ibaba Development Cooperative in the Philippines offers a similar example (Lim, Yap & Devlin, 2015).

As for Africa, recent stories of social enterprises began to attract more attention as a new channel for expressing and realizing innovative responses to development challenges. Thus far the social enterprise literature on Africa is quite limited in comparison to other continents (Granados et al. 2011). Yet, studies on social enterprises in Africa are emerging (see, for example Karanda and Toledano 2012; Abukasawi and ElKarib 2004; Desta 2010). These studies review cases from Rwanda, Gambia, Sudan, Mozambique, Nigeria, Tanzania, South Africa, and Ethiopia. Mair and Scheon (2007) mention Sekem, an Egyptian social enterprise established in 1977, that specializes in organic products and phyto-pharmaceuticals. According to Mair and Schoen, Sekem shares characteristics of success with big and famous social enterprises such as Grameen Bank (Bangladesh) and Mondragon Cooperatives (Spain). One can also see that Sekem's activities are technology-related. There are also currently young technology-oriented social enterprises that work at very local levels in some African countries and are making their presence notable. One example is 'Just Energy', an NGO that promotes renewable energy in low-income communities in South Africa. They engage with some rural communities and cooperatives in establishing revenue-generating renewable energy schemes. Just Energy partners with the communities to provide capital and business deals with energy distribution corporations for the energy project (Williams et al. 2011). Another example is the Ethical Co-op. Located in

Cape Town, South Africa, it partners with small-scale farmers from the surrounding rural area and townships, and introduces organic farming techniques and systems to them along with training and assistance in certification. The co-op buys produce from the farmers and delivers to urban clients (co-op members) (Entrepreneur's Toolkit 2007).

In summary there is a promising potential for social enterprises in developing societies due to their inclination for innovation, their decentralized and flexible nature, their social-economic balance, and their perceived 'realism in idealism'. As Altenburg (2008) notes, the literature on technological innovation in developing countries still leaves room for focus on addressing the peculiarities of these countries, particularly relevant to poverty reducing and socially inclusive technological change. There is also less focus in these countries on understanding the developmental roles of agents of change that are neither the state (or related to the state), nor typical international development agencies, nor conventional commercial businesses. We can use this observation to argue for exploring the abilities of social enterprises as agents of technological change in developing countries, especially by contributing to technology localization.

CHAPTER III: FIELD STUDY METHODOLOGY

Social enterprises (SEs) were examined as potential agents of technology localization in East Africa. This thesis research was conducted under a rural focus program, so the research focused on rural development and rural areas. The researcher investigated social enterprises that are engaged in technology localization activities in rural and agricultural communities. Tanzania was selected for the field research.

FIELD STUDY INTRODUCTION

The main research question was: Are social enterprises effective agents of technology localization in Tanzania?

To answer this research question, three sub-questions on social enterprises as agents of technology localization were selected: 1) Do social enterprises demonstrate involvement in the three activities of technology localization, which are diffusion, institutional support, and technical adaptation?; 2) Do social enterprises in their diffusion activities demonstrate success in identifying and engaging what are described in the diffusion literature as early adopters of innovations?; and 3) Do clients and partners of social enterprises give overall favourable accounts of the technological change that they experienced through the activities of the social enterprises.

The field study collected data to answer the three sub-questions through case studies of technology-oriented social enterprises. Priority was given to rural and agricultural contexts. Additional sub-questions were used to structure the research, such as:

- What strategic approaches do social enterprises use to realize technology localization? Do some technologies show more success in localization than others?

- What forms of institutional barriers or social resistance does technology diffusion face? How can they be explained?
- Are there other indicators of social enterprise effectiveness that can be recognized in the field?

ASSUMPTIONS

Recognizing and Engaging Early Adopters of Innovations

Two main assumptions were embedded in the field study design. The first concerned the concept of "early adopters". Rogers (2003) identifies four main elements in the process of diffusion of innovations: 1) the innovation, 2) communication channels, 3) time, and 4) the social system. He identifies the change agents involved in this process as "an individual [or organization] who influences clients' innovation-decisions in a direction deemed desirable by a change agency." (2003, 366). The adopters of innovations – i.e. the users – are categorized according to their level and time of involvement in the diffusion process: innovators, early adopters, early majority, late majority, and laggards. Among these, early adopters play a key role. Diffusion research identifies early adopters as the "trendsetters" and leaders of change and adoption of new ways of doing things in their communities. Early adopters tend to be more capable economically in comparison to others in the social group (i.e. able to take risks, but not necessarily 'rich') and are more informed and connected; hence well-respected in their communities – enough to be taken seriously when they promote something new. This is in contrast to innovators, who often are looked upon as eccentric and too nonconformist to influence a significant number of their peers (Rogers 2003).

This research assumed that identifying SE clients who exhibit qualities of early adopters will be a good sign for the competence of the diffusion activities of the SE. Since some of the SEs in this field study are relatively young, judging their effectiveness by the quantitative measure of rates of adoption would not reflect their potential but only their current level of achievement. Thus, this study resolved to the assumption that if the SEs show good performance of engaging early adopters, the diffusion literature says that this would be a good indicator for their potential as good diffusors. Researchers who focus on early adopters have been increasing in the fields of development, education and business and have been confirming the critical, possibly decisive role of early adopters in innovation adoption stories (see for example, Brint et al. 2011; Worthington et al. 2011; Huh & Kim 2008). Early adopters can be expected to play an important role in technology localization, particularly in diffusion, and sometimes even in technical adaptation (Ram & Jung 1994; Daberkow & McBride 1998). Hence, effectiveness in technology localization will be enhanced by identifying and engaging individuals who have the characteristics of early adopters.

Cooperatives in Tanzania as Exceptional Social Enterprises

In Tanzania, and in East Africa in general, the term ‘social enterprise’ is a new one. The researcher found that the majority of Tanzanian participants in the research do not use the term, and many were not aware of it, including some of the staff of the case studies. The participants who were most casually and comfortably using the term were foreign staff and partners of the case studies (particularly Western staff). When translating the term ‘social enterprise’ into Swahili, translators told the research that they could not find a ready term to use. After consultations they resolved to translate it to *‘shirika la jamii’*, a term which is already used in Tanzania and means ‘community organization’. That was somewhat understandable since social

enterprises are considered recent in Tanzania in general. However, that statement is true only with a qualifier—if we accept that cooperatives are generally not considered social enterprises there, but simply cooperatives.

Cooperatives are quite established in Tanzania and East Africa, and have been so for decades (Coulson 1982). After political independence, the Tanzanian government initiated and supported an economic development model that had cooperatives at its centre (Nyerere 1968; Hyden 1980). Through the Ujamaa policy, Tanzania witnessed a proliferation of cooperatives in the various sectors of the national economy, but especially in rural and agricultural areas. Many cooperatives still exist. However, the researcher never heard anyone in Tanzania – native or foreigner – refer to cooperatives among the Tanzanian social enterprises. That may very well be the case in the rest of East Africa. This is explainable at even the global scale, since cooperatives are significantly older in origin than all other forms of social enterprise. The assumption that the researcher made for the field study was that cooperatives are too big in age, proliferation and influence to be included in a field study of social enterprises. That is so particularly because social enterprises (save cooperatives) are generally still a recent phenomenon in developing societies, contested in theory and yet immature in practice. The contribution of the cooperative movement to economic and social value creation around the world is independent of whether cooperatives are considered social enterprises or not, and has been extensively studied. It could be speculated that old and big, and state-sponsored, cooperatives in Tanzania may have been active in technology localization activities. This field study did not explore that possibility. A question may arise to whether such cooperatives could be considered part of the state, which is a separate agent of technological change from social enterprises. In any case, the inclusion of old, established cooperatives in Tanzania under the umbrella of social enterprises, and investigating

their contribution to technology localization, is one of the blind spots of this research. In this field study, the researcher chose to focus on more recent forms of social enterprises. However, some of the cases did qualify as cooperatives, but new ones. The Biogas Construction Enterprises (BCEs), which were part of this field study, can be described as unique, small cooperatives, in their own right.

RATIONALE FOR CHOOSING TANZANIA

Tanzania has a unique history of special attention to rural development (Nyerere 1968; Hyden 1980; Jennings 2008). There is also a history of pursuit of technological development. For example, in its national planning there is mention of the concept of technological autonomy. The Centre for Development and Transfer of Technology (CDTT), a department within the Commission for Science and Technology of Tanzania, defines 'technology autonomy' [sic] as the capacity "to create […] an enabling environment [for] making independent and correct decisions on the choice of technology, its evaluation, and internalization, generation of endogenous capacity for adaptation, innovation and development of sustainable technologies" (COSTECH nd.). Tanzania is still, nevertheless, a struggling low-income economy. As of 2015, its HDI (human development index) score was 0.531 ranking 151 in the world, and its IHDI (inequality-adjusted HDI) was 0.396. Yet it is a promising candidate for successful technological transformation. In general, it can serve as a relatively good example for the conditions in large parts of Africa. Now in Tanzania there is an emerging debate on how the state can best support innovation and technological development. From the Prime Minister's office (2015), to the Ministry of Energy and Minerals (2015) to strategic plans of parastatals (SIDO 2014 and TEMDO 2011), there is broad-based support and enthusiasm for promoting technological innovation to tackle development problems and promote private sector involvement. These are

both challenging and exciting times of for the Tanzanian private sector. Such conditions could create an important space for social enterprises. The general definition of the private sector in Tanzania, according to the national private sector policy of 2015, appears to include communal enterprises of different types, such as women or youth cooperatives, saving and credit cooperatives, micro businesses and services and other income-generating activities undertaken by community members (as groups or as individuals). SEs can thus feel comfortably included. Into the 1980s the Tanzanian government intervened heavily in the market and general economy of the country creating a form of command economy (Coulson 1982). Then beginning in the mid-1980s and continuing into the new millennium it started to shift towards a mixed-economy approach. The provision of goods and services was largely a monopoly of the public sector, but later the private sector began to be recognized as an engine of economic growth.

The recent five-year national development plan (FYDP-II) highlights industrialization as a priority, with emphasis on utilizing STI for that purpose. It is aiming to transform Tanzania into a semi-industrialized middle-income country. It acknowledges that state performance in the past has not met expectations in terms of supporting industrialization and furnishing an enabling environment for the contribution of other sectors and it says that this will be rectified (especially with the new elected government that took power in November 2015). The plan also states that it intends to approach industrialization in a "business unusual" manner, which means that there will be "fundamental restructuring and repositioning in government undertakings" (United Republic of Tanzania 2016, ii).

The Tanzanian private sector is still considered in the infant stage. More than 70% of the private sector belongs to the informal economy (i.e. businesses that are not formally registered, regulated or taxed). The private sector is "characterized by low levels of education and skills,

limited access to technologies and finance, the key drivers of inclusive economic growth in developing countries", more especially in rural areas (where 70% of the population reside), as put by the national private sector development policy (2015). That general situation renders a private sector with huge untapped potential. Most of the informal private sector is constituted by micro enterprises. According to the Financial Sector Deepening Trust (FSDT) survey of 2012, Tanzania had a total of 3,162,886 Micro enterprises and Small and Medium Enterprises (SMEs), but most of them are informal. Under such conditions large enterprises dominate economic activity. They dominate the formal economy, they are more visible, more able to promote themselves, and have more access to trade partners (national, regional or international partners). Lessons from mature and strongly emerging economies around the world show that SMEs should have a much higher percentage (above 80%) of national economic activity (Page 2016). "Finally a large proportion of formal sector SMEs, specifically 54%, operate in the trade sector and another 34% is engaged in the services. Very few are engaged in the productive sectors and value addition activities where the largest opportunities for job creation and wealth creation are located." (Ministry of Trade and Industry 2012).

The Tanzanian government now seeks to nurture the private sector, help it formalize, and see it supplied with the growing skills, technology and finance needed to make this sector mature. So, we are currently at a stage in Tanzanian history where the public sector is willing to positively interact with the private sector (and the third sector) to enable favourable growth for all, "in addition to selected public interventions to make markets friendly and performing on a pro-poor manner by simplifying regulations and taxes and de-congesting ports, remove roadblocks, improve the infrastructure (especially power and roads)." (Prime Minister's Office 2015). The enabling environment is becoming more conducive for other agents of technological

change to contribute to development more systematically. Social enterprises could be one of them. This thesis may contribute to realizing that potential.

In addition to this appropriate policy environment in Tanzania the researcher had conducted previous research on rural development planning in Tanzania (Sheikheldin 2015) from which he attained a broad knowledge on the national experience with rural development. The researcher also had lived in Tanzania for several months in 2013, volunteered in some technology innovation projects, travelled around the country, and attained elementary proficiency in Swahili. That familiarity allowed the researcher to follow conversations and be reasonably aware of events and surroundings while in the field.

Due to limited time and resources, Tanzania was the only country where fieldwork was undertaken for this study. However, a fair number of the social enterprises that participated in this research had branches and/or business activities in other East African countries, which made them able to give the researcher some information and perspective on those other countries.

RESEARCH STRATEGY AND METHODS

The chosen approach for this research was a qualitative comparative case study, with some limited use of quantitative data. The cases were social enterprises for which historical and contemporary data were collected. Data were collected to construct narratives of how each social enterprise performed in the area of technology localization and what were the highlights and critical factors of its story. The narratives constructed were then used to compare their experiences and respond to the research questions accordingly. The historical case study approach was deemed suitable because the study tried to understand a process of change and the actions of agents seeking to generate change. To understand a change process, it is useful to

construct a narrative of the process to identify the factors influencing the change. The general steps through which this research went conform to the conventional version of:

Idea → Literature Review → Data collection and organization → Analysis and findings →Writing

While case studies are known to generally belong to qualitative research approaches, there are various arguments with regard to what constitutes a case study and distinguishes it from other qualitative methodologies; i.e. what significant characteristics make it a suitable approach to certain research questions. Bennett (2004) suggests the following characteristics define a 'case' and a 'case study': 1) 'small n' compared to 'large N' of statistical studies; 2) each case includes potential of many observations and intervening variables, which makes it capable of being connected with other cases to form broader findings; and 3) even when instances of a single phenomenon are sufficient for a large N statistical study, case study methods can still serve useful theory-building purposes. This is by testing the theory against a specific case. A case can thus be seen as "an instance of a class of events."

Small (2009) argues that instead of using the term 'small n' we should just call data 'a set of cases' in case study research. This will avoid confusion related to generalizability and replicability of research. Hence, a case is "a well-defined aspect of a historical happening that the researcher selects for analysis" (Bennett 2004, 1513). However, Verschuren (2003) perceives the case study as a 'research strategy' rather than a method. This strategy is differentiated from, and complementary to, other strategies like the survey, the experiment "and (other) quantitative approaches." A strategy means "a coherent set of methods, techniques and procedures for generating and analyzing the research material, as well as the way the researcher looks at reality and conceptually designs the research project" (Verschuren 2003, 122). Verschuren suggests that case study research is a 'holistic' approach, which means that it makes no distinction between research units (e.g. organizations) and observation units (e.g. employees):

> "A case study is a research strategy that can be qualified as holistic in nature, following an iterative-parallel way of preceding, looking at only a few strategically selected cases, observed in their natural context in an open-ended way, explicitly avoiding (all variables of) tunnel vision, making use of analytical comparison of cases or sub-cases, and aimed at description and explanation of complex and entangled group attributes, patterns, structures or processes" (Verschuren 2003, 137).

This field study identified with the articulations of Bennett and Verschuren, above, in its justification for the choice of case study strategy as the methodology for data collection and analysis. The case studies of this research were a small sample that are not statistically representative, and each case was studied as a whole unit (including its staff, clients, partners, products, model of diffusion, etc.).

While generalizable conclusions can be drawn from a largely qualitative case study research, the knowledge it seeks to gain about the topic it studies is not necessarily generalizable or replicable (Hesse-Biber et al. 2004; Goodwin and Horowitz 2002; Burawoy 1998). However, the insights and conclusions learned from such studies enhance scholarly knowledge and understanding for various practical or theoretical purposes. This qualitative approach is often suitable for studying complex phenomena or ones that are highly contingent on their social context. Case studies can create a wealth of in-depth knowledge regarding each case, and this can be built upon with more cases which may eventually generate quantitative significance (Jensen and Rodgers (2001).

In this field study both technological and institutional aspects intersected. Flyvbjerg (2006 and 2011) and Small (2009) argue that one significance of case study methodology is that it allows for studying multiple variables in each case, even with a mix of qualitative and quantitative models. Table 3 shows a number of sample studies that addressed topics of technological change and societal dynamics in mostly developing countries or communities. They used case study approaches, and mainly qualitative data and analysis, but were also

relatively successful in including relevant quantitative measures and data that contributed to illuminating their subject of inquiry. For example, Barry et al. (2008) studied the impact of rainwater harvesting and soil/water conservation systems through both quantitative and qualitative data (soil fertility, crop yields, cost-benefit analysis, socio-economic impacts, gender parity, etc.). They selected a number of sites (cases) in two countries and conducted studies on each site, then combined and compared results from the different sites. They also showed other case studies that included factors of participatory appraisal and farmer-to-farmer learning action research projects. They analyzed results that are related to both technical/quantitative measures (practices with most yields/benefits) and socio-economic (problems of labour and land tenure as constraints to implementing techniques, and women's unfair share in decision making due to lack of land ownership). Kandji et al. (2006) presented case studies of countries of the West Sahel and their peculiar challenges and policies in relation to addressing climatic effects on food security measures, including soil/water conservation. Each country's peculiar context and policies are presented after indicating the larger umbrella variables for the entire region (climate forecasts, shared institutions, shared techniques, etc.). Roy (2002) used both case study research and mixed data (qualitative and quantitative) analyses to investigate why traditional handloom weaving technology in India has a unique record of surviving the new mechanized 'power' looms.

The aspects that played a role in determining research methodology choice, in the sample studies, were: a) the research questions, b) the lens of inquiry (or hypotheses), and c) the contexts of their fields (i.e. where they collected the data). Generally, each sample of case study research in table 3 had perceived weaknesses or left room for speculation regarding what other information or perspectives could have been brought to light if a different methodology was

chosen. Ultimately, however, each study showed why case study strategy was very suitable – if not the most suitable – for its line of inquiry. Another characteristic that appears to be common among these sample studies is their interdisciplinary nature. Harriss (2002) suggests that "good scholarship must involve a tension between 'discipline' and 'anti-discipline". The reason for that, he argues, is because discipline, although productive in the sense that it cumulates scientific knowledge and distinguishes it from opinion, can also be too self-absorbed and isolated from reality if it is not often challenged by outsider perspectives. Harriss encourages continuous cross-disciplinary research (both multidisciplinary and interdisciplinary), particularly for studies under the umbrella of international development. Interdisciplinary research allows for continuous cross-examination of the discipline's tools and findings, by approaches from other disciplines, which keeps the discipline in check, evolving and in touch with the questions of the larger reality. This thesis is interdisciplinary as it links technological and institutional aspects of development, and integrates multiple scholarly disciplines — development studies, technological change, and diffusion of innovations.

Table 3 Summary of selected methodology literature reviewed

Author(s), year and title	Brief Description	Research Strategy
Adeel et al. (ed.) (2008), "What Makes Traditional Technologies Tick?"	Several chapter studies of traditional water management systems around the world. Focus on promoting traditional technology as sustainable development approaches.	Qualitative, case study researches. Historical and technical description followed by analysis and/or recommendations for promotion and improvement.
Gamser (1988), "Innovation, Technical Assistance and Development: The Importance of Technology Users."	Arguing for the importance of including technology users in development planning and implementation. Focus is on showing how policy and management approach affects technology-users inclusion.	Qualitative set of case studies. Historical experiences of development projects narrated with emphasis on the benefit of technology user inclusion in the process.

Roy (2002), "Acceptance of Innovations in early Twentieth-century Indian weaving."	Historical analysis of how traditional weaving technology survived modern technology introduction in India. Focus is on explaining the unique case of traditional weaving.	Qualitative, historical case study research. Data was collected from historical documents that provided mainly quantitative information, with some opinions of other scholars.
Mohammed (200?), Low-energy stoves for Internally Displaced Peoples (Darfur)	Report investigation and evaluation of different stove appropriate technologies. Focus is on determining which stove design is the most appropriate to local conditions.	Qualitative and quantitative (mixed) action research on one case study. Data was collected on both the quantitative performance of the stoves and the qualitative assessment of the technology-users. Data from the technology users was collected in an active workshop without structured questionnaires or interviews.
United Nations (2006), "Gender, water and sanitation: Case studies on best practices."	Stories documenting best practices, from around the world, of gender empowerment projects in the contexts of water supply and sanitation improvement projects. Techniques for early-warning communication systems were introduced, and their impacts evaluated.	Qualitative, set of case studies. Three case study methodologies are claimed to have been used in the several studies of the report: The Harvard Business Case Study Methodology, Appreciative Inquiry, and Feminist Analysis.
Fidiel (2001). "Participatory development of the donkey-drawn plough in North Darfur, Western Sudan."	Report narrating an experience of participatory technology development (PTD) research in a rural context. Focus is on demonstrating the effective aspects of PTD.	Qualitative and quantitative (mixed) methods, case study, participatory rural appraisal (PRA) and participatory action research (PAR). Data was collected from active workshops and implemented designs; no structured questionnaires or interviews.
Ostrom (1990), "Governing the Commons: The evolution of institutions for collective action." Chapter 3, The case of Valencia, Spain, communal irrigation systems.	Challenging the administrative theory of 'the tragedy of the commons' by presenting and analyzing cases of communal self-governing of common-pool resources.	Qualitative, historical case study research. Data was collected from both historical documents and contemporary ethnographic fieldwork studies by several researchers under the same umbrella topic, under the same researcher supervisor who is the author.

Barry et al. (2008). "Rainwater Harvesting Technologies in the Sahelian Zone of West Africa and the Potential for Outscaling."	Studying the impact of rainwater harvesting and soil/water conservation systems – customary and emerging technologies – in the Western Sahelian Zone of Africa.	Mixed methods (quantitative and qualitative), sets of case studies (sites) in two countries and comparative case study. Data collected and analyzed included soil fertility, crop yields, cost-benefit analysis, socio-economic impacts, gender parity, etc. Results were related to both technical/quantitative and socioeconomic measures.
Kandji et al. (2006). "Climate Change and Variability in the Sahel Region: Impacts and Adaptation Strategies in the Agricultural Sector."	Studying countries of the West Sahel of Africa and their peculiar challenges and policies in relation to addressing climatic effects on food security measures, including soil/water conservation.	Qualitative, historical and comparative case studies. Each country's peculiar context and policies discussed in light of the common regional variables (climate forecasts, shared institutions, shared techniques, etc.).

Criteria for Choosing Cases

Type of case: The field study sought cases of business ventures with a primary social or environmental objective, i.e. social enterprises (as defined in chapter II). Each case's fulfillment of this definition was assessed by looking at what they do and their model or structure. Their activities included providing a critical, under-met service to communities; providing technology education or training; or innovating and/or promoting new products or systems. Their model or structure was either a private enterprise, cooperative (or social firm), NGO with revenue-generating branch/activity, or a public-private partnership initiative (such as a revenue-generating technology training centre). Criteria in tables V.1 and V.2 (Appendix V) were used in the selection. For example, table V.1 lists basic criteria that an organization should fulfill to be considered a social enterprise, such as its social or environmental objective and long-term mission, along with how the organization itself is structured and how it reinvests a proportionate amount of its revenues back into its social/environmental mission (rather than distribute most

revenues to shareholders as profits, for example). As for their involvement in technology localization, table V.2 represented a pre-assessment of cases for selection, to measure how new the technological product or service is (to the targeted communities) that the SE is introducing, and how it relates to the livelihoods of these communities (i.e., the technology's socioeconomic and/or environmental value). All the selected cases satisfied the criteria sufficiently.

Process of selection: generally, referrals from primary contacts were used (those that the researcher and his advisory committee already had communication with in Tanzania), or visits to social enterprises known through informal contacts. Initial information letters and requests for participation in the research were sent to potential cases. Also, the researcher used the casual approach of meeting with the organization's manager(s) to briefly introduce the research and its purposes then inquire about whether they will be interested in joining the study. All confirmed participants eventually went through the formal procedure of receiving official information/recruitment letters and signing consent forms.

TYPE AND SIZE OF DATA

Key informant feedback: personnel of SEs, users/adopters of their technologies, and partners in their projects were treated as key informants. They had intimate knowledge of the processes of technology localization that the SEs were leading, whether as providers, beneficiaries, facilitators, or as a combination of those (as will be explained in the findings). Data was collected from them mainly through one-on-one interviews (either in English or in Swahili with the presence of an interpreter). In these interviews they told their stories with the technologies and with the process or model of how they engaged with the technologies either as localizers or as adopters. They also provided their observations and opinions about both the technologies and

the processes of localization. Additional data from key informants were collected through field visits and conversations. Such data were mainly generic (i.e. no personal information collected) or an elaboration on what was already mentioned in interviews.

There were 108 interviews conducted (out of 100 originally targeted for the entire field period). The average time of each interview was 40 minutes. Interviews took place between December 2014 and August 2015. All interviews were conducted in person. Two interviews were arranged to be in writing – one with a senior staff of GCS Tanzania Ltd. and one with a retired senior staff at CAMARTEC – but after the researcher met personally with the interviewees and the two were not able to secure sufficient time to schedule an interview in person. The Tanzania regions in which the interviews took place were: Arusha, Kilimanjaro, Manyara, Morogoro, Dar es Salaam, and Mwanza (With multiple districts and villages in each region). Appendix VI provides a coded list of interviewees (Table 9). Overall, the field study collected and analyzed data from 6 social enterprises, 8 partner/informant organizations, and about 15 communities (in 5 different regions).

Field observations: An average of 7 days for each case were spent in their offices with their staff, and on their field operations. The purpose of the observations was for the researcher to have an accurate visualization of the technology localization process and its confounding factors. Additionally, field observations gave the researcher an opportunity to note any dynamics of interaction between the SEs and the local adopters/users with a fresh, third party perspective, which has the potential of noticing things others may not readily notice. Additionally, the researcher organized his own visits to rural communities and areas where technology adopters and the participant SEs were present. Time was also spent with many partner organizations. Furthermore, the researcher was invited several times to workshops and events that included

important discussions and demonstrations of projects. The researcher took notes about interesting points made, ideas discussed, information reported, and open data/knowledge shared. He also recorded his own observations while in the field interacting with the communities and observing the technologies in question. In total, the researcher attended approximately 15 field events with most of the participant organizations, and took notes. The field events included field visits to rural communities and projects (other than the interview visits), workshops, and technology demonstration or testing events. Some of the field events took several days, but the majority of them consisted of one full day per event.

Relevant literature: Each participant organization (whether a case or a partner/informant) provided the researcher with documents that relate to their work, their business model, organizational structure, history of activities and achievements, sales, programs, and other relevant data. Additionally, the researcher sought and acquired other documents, books and reports relevant to the general Tanzanian context and specific region or business information. A collection of books about Tanzania's policies, capacity and business environment were purchased by the researcher from Tanzanian bookstores and organizations. Additionally, a number of statistical reports were acquired from Tanzania's Bureau of National Statistics, mainly relevant to rural economic activities, production, population and energy. Approximately 72 documents overall were collected.

While the main research question for the field was about whether social enterprises are successful agents of technology localization in Tanzania, the data collection from the field was guided by sub-questions. Table 4 demonstrates the composition of the interview guide—how questions were grouped, what their descriptions were and what the rationale behind them was.

Table 4 Composition of Interview Guide			
Section in interview guide	**Description**	**Rationale**	**Targeted participants***
Background of interviewee (in relevance to the research topic)	Simple direct questions about job (or trade) description, years of experience and professional qualifications (if any)	To seek to understand and contextualize the interviewee's answers to the coming questions based on their relative experience and perspective	SEs, Adopters, Partners
Questions about the organization's approach	Questions combining direct, multiple choice and opinion-based, about the vision, goals, mandate, structure and general composition of the organization	To learn about the general composition and direction of the organization, through the collective responses of interviewees	SEs, Partners
Organization's operational model	Multiple choice question about the origins of the model and its advantages/disadvantages	To learn how the diffusion model is perceived by those who experienced it	SEs, Partners
Perceived attributes of technologies	Likert-scale questions about the how the interviewee things of the technology in question, in terms of: Relative advantage, compatibility, Complexity, Trialability, Observability**	To learn about how the technologies in question are perceived in general, favourably or less, by all those involved in the diffusion process, and particularly the users/adopters	SEs, Adopters, Partners
Diffusion impact – rates of adoption	Questions about sales and regions (and communities) covered in the diffusion process, etc.	To estimate rates of adoption by the measures available (as not all organizations had clear records of sales and coverage)	SEs, Partners
Recognition and engagement of early adopters	Questions about the interviewee's level of engagement and influence in the community, as well as other questions about their technology adoption story***	To determine whether the individual belongs to early adopters or early majority	SEs, Adopters
Perceived challenges and opportunities of business	Open and multiple-choice questions about the internal and external challenges of affairs related to the diffusion or adoption of the said technology	To learn about the multiple and diverse challenges, as well to learn how many of them are agreed by the interviewees to be of priority	SEs, Adopters, Partners
Business with the social enterprise(s) and the products/services involved	Direct, multiple-choice, and 'fill-form' questions about the type of relation and business SE and what products and services are involved and how	To learn from adopters and SE partners how they see and assess the product type of the SE	Adopters, Partners
How communication and marketing for the products/services was conducted	Open and likert-scale questions about assessing the marketing and communication performance of the SE in question	To evaluate the marketing and communication performance of the SE	Adopters, Partners

*i.e. social enterprise staff, technology users/adopters, and/or partners of social enterprise.
**Based on Rogers' (2003) criteria of innovations that achieve good rates of adoption.
***Based on Rogers' (ibid) criteria for recognizing early adopters.
(also see appendix VIII: interview guide for technology adopters)

Interviews were not transcribed verbatim, as they were not recorded. Interviewee responses were written or typed down by the researcher directly during the interviews. This way of recording responses was deemed suitable and sufficient for this research as explained in the research ethics approval process completed with the Research Ethics Board of the University of Guelph. Without their interviews recorded, the participants were generally more at ease in expressing their views and elaborating when needed. They also were comfortable in having the interviews in their workplaces or with some interruptions in the middle of the interview, which made interview scheduling easier for them. It is the belief of the researcher that this approach increased the willingness to participate among interviewees – particularly from rural communities – and it only cost the researcher more work in instant transcription/summarizing during the interviews (either directly in English or through an interpreter present at the interview). With some complex questions or elaborate responses, the researcher often summarized the response recorded back to the interviewee to make sure they approved of the summary. Interviewees either approved such summaries, made some corrections, or added emphases to them.

In 2016, the field research was extended. Field findings from 2015 led to expression of interest from the International Development Research Center (IDRC), and from local research partners such as the Science, Technology and Innovation Policy Research Organization (STIPRO), to learn more about the experiences and reform possibilities of parastatal R&D Tanzanian organizations, also known as Public Technology Intermediaries (PTIs) or Industrial Support Organizations (ISOs). Some of these PTIs participated in the field study in 2015, and a few others were added in 2016. The extended study sought to hear more from the PTIs, through interviews and discussions. With the extension of the field

research, 30 more interviews were conducted with senior personnel from these organizations, as well from the Tanzania Ministry of Industry and Trade and the Directorate of Science, Technology and Innovation in the Ministry of Communication.[7] Also additional documents were collected. After the 2016 field research activities were completed, a conclusion was reached that it would be more appropriate to address the findings of that experience in a separate research chapter (to be prepared with IDRC) as it will be more relevant to the national policy level rather than the social enterprise and rural community level of the main field study. However, the general information and insights learned from the 2016 fieldwork also partially informed the results and data analysis of the 2015 research data, as they served to enhance knowledge about the institutional and economic context in Tanzania under which social enterprises operate and engage in technology localization.

DATA ANALYSIS PROCESS

Data analysis sorted the data using themes of inquiry, variables of categorization (for persons and organizations, to identify early adopters), categories (such as technology type or model of diffusion) and spreadsheets (for grouping likert-scale answers).

Two software programs were used for organizing and coding data: one is the qualitative data analysis software, Nvivo (v.10 for PC) which was used to code data according to research participants (interviewees and organizations) and according to themes (See Table 5). This process included importing all the interviews and other documents collected from or about the participant organizations into one Nvivo file, organizing the data

[7] This directorate has since been transferred to the Ministry of Education by the new government.

into units of reference (organizations and persons) and reading and marking codes according to themes as the researcher continued reading the data. See appendices I and II.

The other program is MS Excel, which was used to organize a database of interviewees, assign codes to individual research participants, organize answers to likert-scale questions from the interviews, and keep track of criteria of cases. See appendices III and IV.

Table 5 Data Analysis Framework (from Nvivo Software)

Data Type(s)	Unit(s)	Variables	Themes
Interviews	Persons	Role Gender Location	Models of Diffusion
Organizational Documents		Feature	Technology types
	Organizations	Type Sector	Adopter Stories
Literature		Orientation	(Recognition and Influence)

Nvivo software allowed assignment of nodes to each unit (interviewee or participant organization). Variables were also added to each node. For example, each interviewee had a role pertaining to their associated organization, gender and location. Some of them had an added variable or 'feature' which was distinct in some way (for example, an early adopter with a unique story, or a social entrepreneur who has been working in technology localization efforts for over two decades). As for organizations, their variables consisted of type (i.e. registered as NGO or private business), sector of work (i.e. types of technology it diffuses) and orientation (i.e. any unique organizational structure). Using the same software, the researcher entered the themes of inquiry as nodes (last column in Table 5). While scanning the data the researcher was able to code any passage of any document to the node or

nodes that related to it. After scanning all the documents, the researcher could recall any unit, variable or theme to find all the passages that relate to it from the coded data.

RESEARCH ETHICS

This research received ethics approval from two entities. The first approval was provided by the Research Ethics Board (REB) of the University of Guelph. The REB considered all issues and procedures of consent, confidentiality, privacy, risk of participation, etc. as per information presented by the research team (which includes the student researcher and his thesis advisor as principal investigator). The REB determined that the methods of data collection and pursued content pose low risks to participants and are sufficiently mitigated by the safeguards of confidentiality in the research. Also, as a requirement from the REB, the researcher completed training in the Canadian Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS2).

The second approval was provided by the Tanzania Commission for Science and Technology (COSTECH), the entity responsible for ethics review for research conducted by foreign researchers in Tanzania.

The field study observed, with official guidelines and the best of intent, the principles of informed consent, confidentiality of research participants (to parameters agreed with them), and respect for local laws and customs in international field research.

DATA COLLECTION SUCCESSES AND CHALLENGES

Overall, the design and implementation of the field study was satisfactory. The field study was able to extract patterns that responded to the research question and sub-questions, as will

be demonstrated in the next chapter. Nonetheless, data collection had some notable successes and challenges.

Successes

The recruitment and consent process proved to be robust. Most interviewees responded with ease and had a good understanding of what the research was about. Non-English speaking participants were generally satisfied with the translated information and consent letters, and each individual participant kept a copy of the information letter and contact info of the research team and the university's REB. Additionally, the planned number of interviews was achieved and surpassed. However, the distribution of interviews among case studies was not proportionate. Some organizations required more interviews than others, for various reasons such as size of organization and its operations, number of staff and currently accessible customers, etc.

The organizations that agreed to participate covered a good variety of business models and technology products and services. They also covered various regions in Tanzania. This variety helps in a comparative study and in examining multiple scenarios in which SEs can act as agents of technology localization in contexts like Tanzania and East Africa. Additionally, a number of the participant organizations either operated in more than one country in East Africa or had strong partnerships with similar organizations in Kenya, Rwanda and Uganda. That also helped to give a fair East African perspective.

The field visits, for field observations, proved to be very educational. The researcher was able to see both similarities and differences among rural communities in different regions of Tanzania. The networking that took place to approach many potential participants

was relatively successful. Persistence with communication and follow-up rendered satisfactory results.

Problems and challenges

A number of SEs had reservations about participating in the research. Some of them are relatively 'big players' in the field and it would have been beneficial if they had agreed to participate. Two SEs officially declined to participate in the research, citing commitment to other researchers or lack of time as reasons for declining. Two other organizations continued to delay their response to frequent requests and follow-ups until the end of the field research period. Fortunately, some of the business and diffusion models and the technologies these enterprises provided were more or less covered in the research by alternative cases.

Scheduling of interviews and field visits was another persistent challenge in the field, for both circumstantial and human-related reasons. Often after appointments were secured, after persistent contact and follow-up, events were cancelled due to absenteeism or road problems (especially for interviews in remote rural communities). Since the interviews were based on voluntary participation and without any remuneration, a number of potential participants (individuals) simply refused to participate or did not show-up for appointments. In a number of cases the researcher travelled for long distances for scheduled appointments (often with a Swahili interpreter) only to find out that participants left their homes or farms for other errands without giving prior notice. In such situations, the researcher had to make do with fewer interviews, look for other possible interviewees, attempt to reschedule, or just settle for only taking field observation notes.

Objective and contextual circumstances surrounding data collection did not allow for uniform or equal representation of individual interviewees from each case study (staff or

clients). For example, while the core staff of any of the cases did not exceed 8 individuals, they still varied from 8 in one case to only 2 individuals in another. Additionally, not all core staff were available for interviews, for logistical and geographical reasons. Additionally, depending on the size of their operations and networks, as well as their age, the cases varied in the number of their clients and partners as well as their presence in various communities across Tanzania's regions. Accessibility was also an issue, since some SEs kept a good record of contacts of clients – so the researcher could reach them – while others did not.

The interview guidelines were flexible, but were still not inclusive of the various cases and experiences. In some situations the interview questions were modified to relate to the context. This variance in interview questions and answers posed a challenge later with the detailed analysis and comparison of interview answers. Additionally, a significant number of participants (individuals and small organizations) could not be neatly placed as 'social enterprises' or 'technology users' or 'partners', but rather were a combination of these categories and more. For example, the Biogas Construction Enterprises (BCEs) were business entities created by masons who were trained and certified in building and marketing biogas digesters by the Tanzania Domestic Biogas Programme (TDBP). These masons were recipients of a service, but were also technology adopters and users as they were often small-scale farmers who eventually built subsidized biogas digesters on their own farms. Additionally the masons who create the BCEs often work in a unique, small cooperative model (which makes them SEs) and diffuse biogas technologies in their communities. The same individuals were customers and technology users on one end, and technology diffusers with an SE model on the other end. The researcher chose to accommodate their case because it is quite dynamic and important for responding to the research questions. As much as a

methodological challenge, they were also a good find. That accommodation also posed further problems in the data analysis, as they did not fit pre-determined categories. It was a methodological challenge but a good challenge to have nonetheless. This unexpected find contributed more information and material for thought than it was a challenge—a common lesson from qualitative field research.

Furthermore, it was not a simple task to secure one translator/interpreter for the entire research period. A translator/interpreter could not be employed full-time for this research, as need was occasional and depended on securing interview appointments with some participants who prefer to do interviews in Swahili or who are not comfortable enough with English. Moreover, travelling was a challenge as some translators/interpreters were not able to travel to other regions with the researcher due to their other commitments (such as their full-time jobs in Arusha or Dar es Salaam). To mitigate, the researcher contracted three translators/interpreters and oscillated between them for various Swahili interviews and translation tasks as their schedules permitted. All translators/interpreters signed a pledge of confidentiality as agreed with the University of Guelph's REB.

CHAPTER IV: FIELD STUDY FINDINGS

As iterated in the previous chapter, the field study attempted to find credible answers to overarching questions about the viability of the social enterprise (SE) approach to localizing technology in rural communities in Tanzania. This chapter presents the main findings. First, a description of all the participant organizations and the technologies they covered will be presented. Then, to respond to the research question, data findings will be presented responding to the three main sub-questions set out to determine the effectiveness of SEs in technology localization:

1) Do social enterprises demonstrate involvement in the three activities of technology localization, which are diffusion, institutional support, and technical adaptation?

2) Do social enterprises in their diffusion activities demonstrate success in identifying and engaging what are described in the diffusion literature as early adopters of innovations? and

3) Do clients and partners of social enterprises give overall favourable accounts of the technological change that they experienced through the activities of the social enterprises?

CASES AND TECHNOLOGIES

Below each participant SE case is described. This is followed by a listing of other organizations who participated in the research as information sources and partners of SEs but not as cases themselves. Then the groupings of technologies or technology types promoted by the research participants are described. Table 6 provides a summary of the SEs that participated as case studies, as well as the other organizations that participated as informants but not cases.

The Cases

These are the organizations that agreed to join the research as cases. Each one of them was offered the option of keeping their organization's name confidential. None chose that option. The cases are:

GCS Tanzania Ltd.:

GCS refers to 'Global Cycle Solutions'. The acronym is becoming more prominent as the organization is seeking to diversify its profile from the original idea portrayed in the name (AS10 interview. See Appendix V for codes of interviews).

GCS is a small-to-medium sized private enterprise that was first established and registered in Tanzania by an American engineering graduate (currently the CEO), after she worked in the country on a design project for a bicycle-driven small maize-shelling machine, then teamed up with a local technology innovator and a few young technicians to start a small production and sales unit for this product and a few others (AS10, AS06 and CS02 interviews). According to the interviews with the management and staff, GCS self-identifies as a social enterprise.

GCS currently provides a list of products for rural communities: solar PV light products, energy-efficient cookstoves, and small agro-processing products. According to the senior staff, in its early years GCS used to sell both its own products and products not produced by it, but nowadays it almost exclusively sells products made by others and has discontinued development and sale of its own products. Whether it will return to producing and selling its own products remains to be seen.

GCS uses direct sales and sales by some conventional retail distributors, as well as through a nationwide network of local entrepreneurs. This network was innovated and built by GCS itself. Its team of office and field staff of close to 40 persons are located in

various parts of Tanzania, but mainly in Arusha and Morogoro. Most staff are Tanzanian nationals, with a few non-Tanzanian staff and occasional interns and volunteers. The network of local entrepreneurs that GCS built is called the Rafiki Network, which consists of local village entrepreneurs who are both customers and distributors for GCS (As explained in GCS senior staff interviews, as well as DS01 interviewee who was a part of the early launch of a software to manage the network). GCS also calls the network a last-mile distribution model (AS10, AS01 and AS20 interviews).

KAKUTE Projects Co. Ltd.:

KAKUTE is a veteran Tanzanian social enterprise with over 20 years of experience and a record of successful projects with nationwide impacts (KAKUTE's profile and registration under Tanzania Company Act, 1995). The name is made up from the first two letters from each word in 'Kampuni ya Kusambaza Teknolojia" (Swahili for 'company for technology diffusion'). KAKUTE Projects Co. Ltd. (hereafter 'Kakute') was reincorporated in 2002 as a company "limited by guarantee and not having a share capital" (company's re-incorporation certificate, United Republic of Tanzania), which made even officially closer to a social enterprise than it had been, considering that the Tanzania Company Act does not yet have an official recognition of the social enterprise status. A limited by guarantee company with no share capital and no charitable status comes very close to a legal definition of a social enterprise as defined in chapter II. Kakute's activities have been characteristic of a social enterprise since inception and without being aware of the terminology of social enterprise. Only around the time of re-incorporation did Kakute start to self-identify as a social enterprise (FS01 and FS02 interviews), particularly in communicating with Western partners and potential partners

who recognize the term and consider it favourably. The activities of Kakute remained relatively the same after reincorporation.

Kakute facilitates the development and application of innovative approaches to diversify and improve technology transfer and information to rural communities and small scale entrepreneurs who seek to introduce new products or to employ new systems for sustainable development. It was co-founded by an engineer who became a social entrepreneur, and who is still the managing director. Years before the term ‘social enterprise’ reached this part of the world, the co-founder of Kakute embarked on establishing an organization that could possibly be the oldest Tanzanian SE (save cooperatives). Kakute has executed and completed many projects since inception. Its main mission is diffusing good technologies in targeted communities to improve various aspects of livelihood and push for sustainable development (FS01 interview and company profile). Kakute does that in multiple ways, which include:

- The introduction of new products or services through revenue-generating schemes (on access to food security, renewable energy, and good land use).
- Providing business development services (BDS) for micro and small enterprises and for community based organizations (CBOs).
- The incubation of innovative technology-business solutions.
- Partnering with other local and international organizations to deliver technology solutions to selected beneficiaries.

Biogas Construction Enterprises and the Tanzanian Domestic Biogas Programme (TDBP):

TDBP is a nationwide initiative, only a few years old, with the aim of creating a viable commercial sector for biogas technology in Tanzania. TDBP tries to achieve that by providing training, advocacy, promotion and temporary subsidies for the construction of

biogas plants of different sizes across the country; particularly plants suitable for rural households and small farms. Up to September 2015 well over 12,000 biogas digesters have been constructed in Tanzania under the programme (TS01 and TS02 interviews). Since initiation in 2009, TDBP has been hosted by the Centre for Agricultural Mechanization and Rural Technology (CAMARTEC), a public technology intermediary (PTI). This hosting arrangement is common among other domestic biogas programs in Africa as they operate under the same umbrella directive (TDBP Programme Implementation Document for Phase II, 2013). However TDBP oversees its activities and budget autonomously through a national coordinating team.

According to interviews with members of the national coordinating team (TS01, TS02, TS03 and TS04) TDBP carries out the diffusion of biogas digesters by providing training and certification for masons who, after training and testing, can become independent contractors constructing certified biogas digesters for any client in Tanzania. These certified masons are responsible for constructing digesters up to standards and reporting their work in formal ways that guarantee that clients receive good quality digesters and follow-up when needed. The masons are also often entitled to some subsidy schemes through TDBP to support their work and reduce the cost on the clients (thus making more clients interested). Hundreds of certified masons now exist, with many of them currently earning a substantial part of their income from biogas construction (and periodical maintenance) (TS01, TSO2).

Masons are also encouraged, through TDBP and implementing partners, to form Biogas Construction Enterprises (BCEs) which can be registered as private businesses. The majority of the owners and co-owners of these BCEs are certified masons. Many of

these BCEs end up operating technically as cooperatives, with masons being both the workers and owners of the business. At the time of the field study there were 62 registered BCEs in Tanzania, spread across the country, with many of them formed by a group of certified masons (TS01 interview). The BCEs are groomed by TDBP to be the initiators of a growing, nationwide commercial sector for biogas in Tanzania. As a programme, the TDBP is expected to discontinue once there are many mature and flourishing BCEs and once there is a stable demand for biogas in the country.

Dorgo Agro-Enterprises:

A fairly new Agro-machinery engineering firm, established, owned and managed by an engineer who also works in a senior engineer at a parastatal institute (at the time of the field study) and who has a profile of innovative designs that received international recognition. Dorgo Agro-enterprises (hereafter Dorgo) designs and builds agro-machineries, provides accessible payment plans for small farmers, and volunteers engineering consultancies for organizations that work on agricultural development in Tanzania and East Africa (GS01 interview).

Although quite a small firm, with a small workshop and very few part-time staff, this enterprise is active in addressing small farmers' needs in various ways, some of which are directly revenue-generating and others are indirectly so. Dorgo does not often self-identify as an SE, but its owner sees that it fulfills the SE general criteria (GS01 interview). Because it operates mainly locally, with local partners and customers, Dorgo does not find it beneficial to use the 'social enterprise' term as it is not quite known or distinguished in the Swahili and Tanzanian context. The vision and core work of Dorgo is credited to its owner, who can be described as a Tanzanian social entrepreneur, based on

his activities that also include volunteering his technical knowledge, without charge, to improving agricultural technical training in rural communities through preparing manuals and giving training workshops (GS01 interview).

AISE-Twende (or Twende[8]):

This organization is a merger of two smaller organizations. One is AISE, which stands for 'Accelerating Innovation and Social Entrepreneurship' (while the pronunciation of the acronym sounds like a Swahili word, 'aisee', an expression of awe). The other one is Twende, an appropriate technology NGO in Arusha. Both organizations are fairly new (the older, Twende, was established in 2007) (Twende Constitution, May 2008). Having technological innovators on both sides (a Tanzanian inventor/technician and a retired British engineer) and with both interested in designing and building appropriate technology products for local low-income communities, the two organizations started collaborating with each other and shared office space and machine workshop for a few years. In 2014 a main joint-project made them restructure themselves into one unit, which later became formalized as a permanent merger (interviews CS01, BS01, CS03 and CS04). AISE-Twende also shares premises and history with GCS, particularly through the co-founder of both (CS01 interviewee) who is a Tanzanian technology innovator and educator.

Twende (the merger) acts mainly as an innovation centre which provides space for local young innovators with appropriate technology ideas. It also provides training and incubation services. The same organization produces and sells some products, in

[8] The name was changed to just 'Twende' during the span of the field research. For the rest of this manuscript, Twende refers to the merger AISE-Twende.

limited numbers, such as a small drip irrigation kit, a bicycle juice blender, and solar water heaters.

RafikiSoft:

RafikiSoft started as a team that was assigned with building a software to facilitate the communication logistics and financial transactions (via ICTs) of the Rafiki Network (established by GCS), They are now an independent and new SE operating in East Africa with expansion plans. "RafikiSoft develops enterprise quality and mobile-friendly IT and data management solutions for companies operating at the Base of the Pyramid (BoP) in developing markets." (Jackson 2015). ICT is a major technology sector with many stakeholders in Africa, as expressed in the introduction of this manuscript. This is the smallest and youngest enterprise among the cases of this research, established in 2014 and with only two co-founders who are also the company's only and part-time staff (DS01 interview). Its niche is unique however: a social enterprise that provides tailored ICT services for other social enterprises. In that sense it is different from the other cases in this field study. It is also significantly smaller than any of them. Being a small and new ICT service it did not need more than two co-founders to operate, with hopes of growing in the future. This SE was functioning during the time of the field research, but afterwards we came to know from the participant co-founder (DS01) that it will not likely continue.[9] Yet its example is important to highlight since it is the only ICT-based social enterprise in this study and it had a customer for over a year while it was in operation; that customer being GCS, another major case SE for this study.

[9] According to a recent brief update from the co-founder of RafikiSoft (DS01), on March 19, 2017, this SE is currently not active in business. There are yet possibilities of returning to activity in the near future.

Informant Organizations

These are organizations that agreed to join the research not as case studies, because they do not fit the criteria for cases, but as information and informed-opinion providers. They gave the research access to some of their organizational documents, interview time with their leading staff, and opportunities for observing their work in the field:

- Small Industries Development Organization (SIDO): This is a Tanzanian public technology intermediary (PTI). It is mandated to create, promote and sustain innovative entrepreneurial base by providing SMEs with technical services, training, market intelligence, and business incubation. It reports to the Ministry of Industry and Trade.

- Centre for Agricultural Mechanization and Rural Technology (CAMARTEC): This is a Tanzanian PTI, mandated to function as an innovation centre for testing and building agricultural machinery and rural technology, disseminate improved technologies for agricultural and rural development, and support small enterprises that embark on innovating and marketing agricultural or rural technological products. It reports to the Ministry of Industry and Trade.

- Tanzania Engineering & Manufacturing Design Organization (TEMDO): This is a Tanzanian PTI, mandated to research, develop and transfer plants and equipment for commercial manufacturing and deliver competitive engineering manufacturing knowhow and R&D services to the industrial sector. It reports to the Ministry of Industry and Trade.

- Science, Technology & Innovation Policy Research Organization (STIPRO): This is a Tanzanian NGO that carries out policy research on ST&I policies and decisions, and undertakes capacity building for conducting ST&I policy research.

- MVIWATA: This is a national coordination and capacity-building organization for farmer associations and cooperatives across Tanzania. As described by its own promotional material, Mviwata is "a national farmers organization which brings together small holder farmers from all regions of Tanzania in order to have a common voice to defend economic, social, cultural and political interests of smallholder farmers."

- ECHO East Africa Impact Centre: This is an international NGO that focuses on extension services for small farmers in East Africa. Their services include technological support, training, provision of seeds, supporting appropriate technology projects and hosting relevant conventions.

- SNV Netherlands Development Organization (Tanzania office): This is a large, veteran non-profit international development organization from the Netherlands that was established 1965 under the Dutch Ministry of Foreign Affairs.
- Tanzania Renewable Energy Association (TAREA): This is an association of NGOs and enterprises that work on promoting renewable energy solutions in Tanzania. A number of the participant organizations in this research are members of TAREA, such as Kakute, TDBP, and GCS. TAREA invited the researcher to its Northern Zone AGM, held in Arusha, May 2015.

A representative sample?

The cases that participated in the study represent a fair sample of the social enterprises in Tanzania that were involved in rural technology localization activities. Thus, what was learned from them can represent fair generalizations about such organizations in Tanzania. That was so due to two considerations. First, the researcher surveyed all the SEs in Tanzania that he came to know about through various sources (e.g., networks of development actors in Tanzania that responded to the researcher, networks and contacts of informant organizations, internet search, asking other researchers in Tanzania with whom the researcher was acquainted, etc.). It was confirmed by the search that the number of SEs in Tanzania working in technology diffusion activities is limited (close to 30 at the time) and that most of them have offices or headquarters in Arusha.[10] Among those the researcher narrowed down the list of viable candidates (per criteria of selection) to about 15 or 16 potential participants.[11] Two of them declined to participate after the researcher approached them, 2 could not be reached as all the attempts of the researcher to get in touch with them were not successful, and 2 agreed to participate only partially

[10] Arusha has a large scene of development organizations, international, regional and local. The researcher already knew of this beforehand and chose to be based in Arusha because of it.
[11] The criteria of case selection was described in chapter III. For example, being a social enterprise active in Tanzania was not enough. They also had to be involved in activities of providing technological products and services to rural communities.

by providing general information through interviews with management but not more. Another one did not give the researcher a definite answer until the fieldwork time was over. A few others were in distant regions of Tanzania and the size and type of their operations did not justify the logistics of spending considerable time solely with them. However, for the SEs that did not participate, the types of technologies they were active in localizing, and the business models they used, were fairly represented by other participant cases in the study. The second consideration is that the researcher conducted a thorough search to learn about the existing social enterprises in Tanzania, their quantity and sizes of operations. In that search, the researcher consulted organizations with thorough knowledge about ventures and activities in Tanzania that could fall under the umbrella of social enterprise. For example, SNV, TAREA and ECHO, all had considerable knowledge of the active organizations in their areas of work, which covered a wide range of development activities in Tanzanian rural communities. For example, SNV was actively seeking out technological innovators and entrepreneurs who provide unique development services to Tanzanian communities (e.g., youth employment, renewable energy diffusion, etc.) to support them with capacity building services as well as funding. Being a large organization with years of experience in Tanzania, the researcher sought to learn from them about the size and impact of the social enterprise sector in Tanzania, particularly SEs involved in technology localization activities (interview XX02). Based on their list of such organizations, the researcher had identified most of the significant potential cases in Tanzania, and already recruited some of them for this research. The same story happened between the researcher and CAMARTEC, as well as TAREA. The researcher also attended a biennial symposium and exhibition held

by ECHO which summoned innovative organizations in East Africa (3-5 February, 2015, Arusha) that introduce a myriad of technological products and services. By attending the symposium, the researcher was exposed to a variety of these actors. Again, several significant participants in that symposium were already known to the researcher and some of them had already been recruited for the research. Given these considerations, the researcher is confident that the full range of SEs working technology localization in rural Tanzania have been represented in the sample.

Technology Types

Technology types refer to the categories of technologies that are currently being localized by the case SEs in Tanzania. In the field we observed that the vast majority of technologies being diffused currently by SEs can be categorized into a limited number of groups (or types) by their functions. Generally, there were two major technology types:

Sustainable Energy:

This type includes renewable energy technologies and energy-efficient cookstoves. The renewable energy technologies include solar-charged lanterns, small solar PV panels and associated household items (mainly chargers for light and phones and radio), biogas digesters, and locally-made solar water heaters.

GCS, Kakute, BCEs, and Twende, were involved in the diffusion of sustainable energy technologies (sources: interviews, company documents and brochures, and field observations). Through various technology diffusion strategies, sustainable energy appeared to be a technology type of clear interest for SEs. Interviews with clients of GCS, Kakute and TDBP showed that sustainable energy technologies have clear demand in most rural communities in Tanzania.

Tanzania has one of the lowest electrification levels in the world, with only approximately 36% national electricity access rate (11% in rural areas) (Renewable Energy in Africa 2015). Moreover, the households connected to the national grid experience frequent power outages that can sometimes last for days, something which the researcher witnessed in Arusha in 2015. Since it is evident that overall socioeconomic development requires comprehensive access to electricity supply, energy is everyone's concern. Yet with such crisis an opportunity is presented—Tanzania is a candidate for alternative, decentralized renewable energy supply. The National Energy Policy of 2015 emphasizes that renewable energy will have more support and proliferation in Tanzania. Many SEs are already heavily involved in the business of providing off-grid renewable energy supply to rural households and communities.

To see the how technologies diffused by SEs are perceived, the interview guides contained questions about the perceived attributes of technology products (i.e. relative advantage, compatibility with context, triability and observability). As Table 4 in chapter III shows, these questions about the technologies were asked to most interviewees, including technology users and partners of SEs (See Table 10: Responses of interviewees about perceived attributes of technologies, Appendix VII). It was found from the responses that sustainable energy technologies are generally perceived to be relatively advantageous compared to existing ones (e.g. solar lanterns vs. kerosene lighting, or biogas stoves vs. charcoal stoves). These technologies were also found to be generally not very complex to adopt, with generally favourable value-for-money (or benefit-for-cost) ratios.

While solar PV (photovoltaic) lanterns and power systems generally received very positive feedback from users in this field study, the most positively perceived sustainable technologies by adopters appeared to be biogas digesters (Table 10). Biogas is a simple technology that recruits the help of anaerobic bacteria, in the absence of oxygen, to break down organic matter and produce a mixture of gases in the process. Biogas plants (or digesters) are fed with organic matter (such as animal manure, plant waste, food waste, and sometimes human waste) and produce biogas and bio-slurry. The biogas is captured and can be burned for cooking or lightening, or can be pushed further into an electricity generation process. According to interviews TS01 and TS02, and the TDBP Programme Implementation Document (2013), there are numerous reasons for biogas technology to be quite attractive for agricultural communities:

- Economic: production of a highly-wanted thing from an unwanted thing, i.e. energy from waste
- Environmental: capturing and using greenhouse gases (such as methane) that are otherwise released into the atmosphere. For some communities, access to biogas cooking saves many trees from ending as firewood. It has been estimated (TS01) that one small biogas plant can save 3 tons of fuelwood per year.
- Agricultural productivity: the bio-slurry, which is the second by-product of the anaerobic digestion process, is quite a good soil nutrient. It can be used in multiple ways to improve the quality and quantity of produce (TS01, TS02, and TDBP Implementation Document 2013). Thus it also provides an organic substitute to chemical fertilizer.
- Health and hygiene: an efficient way of managing otherwise problematic waste (such as animal excrement) especially in the absence of modern sewage systems. Also using the biogas for cooking is a much better alternative to charcoal and firewood cooking which produces unhealthy smoke. It has also been found that the bio-slurry is quite a good insect repellent (TSU06, TSU07, TSU14, TSU14, and others).
- Social: the social impact of having access to energy for some off-grid communities in developing societies can be a quite significant value for them. Besides the ability of children to study at night, women also are freed from the

> toils of time and effort spent in collecting firewood for cooking, and can now use that time in various activities that can enhance their livelihoods and more.

While a biogas digester costs much more than the popular solar lantern, most of the persons who eventually paid for a digester and reaped its benefits reported that they were satisfied with their initial investment (most of the 'TU' interviews); which is perhaps due to the larger array of benefits from biogas digesters explained above (and reiterated by interviewee users of biogas and bio-slurry). The digester design that is used by BCEs is a local design by CAMARTEC engineers, named the fixed dome Modified CAMARTEC Design (MCD) Model. This design proved to be robust and popular enough that it was adopted in other countries as well, such as Brazil (according to interviews TS01 and XX02).

Agro-machinery:

This technology type includes agro-processing, pre- and post-harvest (but mostly post-harvest) tools and machines. Examples of the products in this type include maize-shelling machines (mechanized and human-powered), hay balers (manual, non-mechanized), seeders, grass choppers (mechanized), and rice/sorghum threshers (mechanized and human-powered). Although there are other agro-machinery technologies that are in planning to be diffused by some of the case SEs, they were not officially diffused yet, such as multi-purpose tractors and small combined-harvesters (operated by power tillers) which were planned by Dorgo.

One of the cases (Dorgo) was exclusively focused on agro-machinery. However, both GCS and Twende had some small, non-mechanized agro-machinery products that they have diffused within limited circles (CS01 and BS01 interviews). For example, Twende had a pilot product of a small drip-irrigation kit, made locally and from simple

local materials, and already sold some items of this product to a small list of less than 10 users (BS01 interviewee). According to interviewees CS01 and BS03, there are on-going plans to improve and then mass produce and distribute the drip irrigation kit.

From the few interviews conducted with the adopters of Dorgo's technology (GU01 to GU06 interviews), it was found that agro-machinery technologies are generally perceived to be relatively advantageous compared to existing ones (i.e. compared to mostly manual techniques). However, these technologies were also found to be more complex to adopt than sustainable energy ones, since they require a learning curve to operate efficiently. Additionally, there was no clear consensus among the adopters that these technologies had good value-for-money ratios; perhaps because their cost was not generally small and they require a long time to observe financial benefits above the initial capital investment.

We had fewer interviewees about agro-machinery technologies than those interviewed about sustainable energy technologies, particularly because most of the SEs that participated as cases in this field study worked with sustainable energy products (and fewer agro-machinery products). Only Dorgo focused its work on agro-machinery technologies.

Other technologies:

There were other technological products and services provided by SEs that may not necessarily be considered within the two technology types of sustainable energy and agro-machinery. Kakute, for instance, produces and sells personal care products made

from jatropha oil. Also, RafikiSoft launched the service of RafikiNet, a software that belongs to the ICT technology type. RafikiNet is a product to be sold to small-to-medium companies and SEs that would like to have a communication network with rural agents and distributors in developing countries. In that sense, RafikiNet's targeted market are not rural communities themselves, as technology adopters, but rather businesses that work with rural communities and rural entrepreneurs. RafikiSoft considers itself a social enterprise that serves other social enterprises (Jackson 2015 and DS01 interview).

Table 6 Inventory of research participant organizations

	Organization	Size*	Established since…	# interviews conducted**	Technologies diffused	Model(s) of diffusion
Case Studies (Social Enterprises)	**GCS Tanzania Ltd.**	30-40 employees (excluding the Rafiki Network, which has about 100 active individuals); multiple regions in Tanzania and Kenya; 3 offices in 3 regions, including inventory container, workshop; at least 4 vehicles; over 50,000 households served between 2011 and 2014.	2009	26	Solar Lantern Family Line (made in USA); Energy-efficient cookstoves; Maize-shellers (manual and bike-mounted); and others	Microfranchising; regular retail sales; local distributors (conventional retails businesses)
	KAKUTE Projects Co. Ltd.	~10 employees (used to be more, about double, a few years ago); Northern Zone (3 regions); one main office on relatively big premises well-maintained, with warehouse and hosting other companies (incubatees and partners); one vehicle.	1995	29	Solar Lantern Family Line; Solar PV panel small systems; jatropha-based personal care products; and other products Also technology services: technical consultancies, training, incubating, renewable energy school program teaching, etc.	Technology-business incubation; direct marketing and sales; training provision; educational programs; promotion campaigns
	Biogas Construction Enterprises (BCEs) (Tanzanian Domestic Biogas Programme - TDBP)	TDBP has ~25 employees, nationwide program with multiple offices and vehicles; main office hosted by CAMARTEC; BCEs are multiple and nationwide, with each having between 4 to 20 employees and some with small offices; so far over 12,000 biogas digesters constructed all over Tanzania.	2009	24	Biogas digesters construction and maintenance, with gas pipe connections for cooking and lighting.	Sector enterprise cultivation (TDBP); direct sales and marketing (BCEs)
	Dorgo Agro-Enterprise	3-4 employees; one small office and small workshop (yet with access to bigger workshops when needed); technically serves nationwide but still currently mostly confined to Northern Zone. ~20 products (agro-machinery) sold so far.	2012	9	Agro-machinery products, variety of mechanized and manual products.	Direct sales and marketing; training provision (volunteering); renting of machinery

	Twende (or AISE-Twende)	5-10 employees; one office and workshop; one vehicle; no estimates of sales over years but not many, as most work is not commercial yet	2007	8	Solar water heaters, agro-machinery, drip-irrigation kits, and others. Also technological and innovation services: hosting and coaching innovation projects, school classes for appropriate technology, etc.	Direct sales; training and coaching provision (paid for by NGOs instead of direct users/adopters).
	RafikiSoft	2 co-founders (no employees); no office (virtual office); so far one main customer (GCS Tanzania Ltd.), few consultancies and prospects	2014	1	ICT: RafikiNet: ERP (Enterprise Response Planning) or a business management platform	Direct service contracts
Other organizations	**SIDO – Small Industries Development Organization**	Very big, nationwide, parastatal organization; multiple offices, operations, fleet, etc.	1973	1		
	CAMARTEC – Centre for Agricultural Mechanization and Rural Technology	Big nationwide parastatal organization; one main large HQs with offices and workshops.	1981	6		
	MVIWATA – a national farmers' organization	Big nationwide NGO, with regional offices, serves smallholder farmers and their associations nationwide.	1993	2		
	STIPRO – Science, Technology & Innovation Policy Research Organization	Think Tank NGO, ~10 employees, one office, serves nationwide and abroad.	2008	1		
	SNV – a Netherlands' international development organization	International Organization	1965	1		
	TAREA – Tanzania Renewable Energy Association	Nationwide association of renewable energy businesses and NGOs	2000	1 (interviewee from KAKUTE)		
	TEMDO: Tanzania Engineering & Manufacturing Design Organization	Big nationwide parastatal organization; one main large HQs with offices and workshops.	1980	1		

*Size of organization considers the following (all or some): number of staff; size of operations (e.g. area covered, sales, etc.); size of assets (e.g. offices, vehicles, workshops and big equipment, etc.). Some numbers are approximations because accurate numbers were not provided or on record.
**for social enterprises, number of interviews includes interviews with staff, technology adopters, and some partners whose interviews mainly revolved around the products and operations of the respective social enterprise.

CASES AND LOCALIZATION ACTIVITIES

The first question regarding the effectiveness of social enterprises as agents of technological change was to determine whether social enterprises demonstrate involvement in the three activities of technology localization—diffusion, institutional support, and technical adaptation. Diffusion requires communication about and promotion of new technological innovations. Institutional support includes policy advocacy, resource mobilization, and logistical assistance for chosen technologies. Technical adaptation includes incremental, technical modifications to technologies in ways that add value and increase local utility of the technologies. It was found that as a group the case SEs were involved in these activities but no case was thoroughly involved in all three activities.

Diffusion

The cases that were clearly involved in diffusion were GCS, Kakute and TDBP. GCS innovated a nationwide diffusion network that it called the rafiki network. *Rafiki* in Swahili means 'friend', and the network is based on a group of independent sales representatives and distributors who are trained by GCS in handling and marketing their products. Each individual representative/distributor is called a *rafiki*. Most of them are both users of GCS merchandize – mainly the solar PV lanterns, some solar cookstoves, and a few manual maize shellers – as well as local entrepreneurs who distribute these technologies locally. However, they are also free agents who made the voluntary choice of partnering with GCS locally because of the potential they saw for the technology products after trying them as users. There were interviews with 16 *rafikis* from various parts of Tanzania, and they generally revealed GCS' comprehensive approach to diffusing their products (interviews AU01 to AU16, Appendix VI). The diffusion generally proceeds along the following line: the GCS field officers seek out and recruit *rafikis*,

through persuasion, marketing and selection, and then the *rafikis* use similar diffusion techniques to market and sell GCS products to their communities. This approach has been called 'microfrachising'. According to GCS staff (AS01 and AS11) in 2015 the rafikis in the network were about 120 individuals spread across Tanzania (and a few in Kenya).

The GCS products sold by rafikis are generally the solar-charged lanterns of various sizes (small, medium, and large) with additional features such as outlets for mobile phone charging – including USB charging outlets for smart mobile phones – as well as multiple-lantern systems with a battery that can charge more than one mobile device. Other products include small energy-efficient cookstoves and a bicycle-attached small maize sheller. One can see that these products generally target communities with limited or no access to the electric grid, many of whom also happen to be involved in small-scale farming with mostly manual labour. As described earlier, *rafikis* are chosen through a recruitment and screening process. Typically, GCS field officers make first contacts with the targeted communities by introducing themselves to the district officers and village councils of those communities, or to community-based organizations like churches or SACCOs (Small Saving and Credit Cooperatives). After that they secure an occasion allowing them to introduce themselves to the general membership of the community, as well as introduce their products and announce their interest in finding local partners in the community to be *rafikis*. If the work of marketing the products, the company's brand, and the microfranchising idea succeeds, a number of community members will express interest in becoming *rafikis*. From that point GCS will collect applications of interested community members, make a selection of a few, and provide training for the selected individuals on the products and the sales system after which they may be ready to take initiative and start marketing and selling the products (AS01, AS03 and AS10 interviews). How the *rafikis* perform afterwards

– after selection and training – determines whether they grow to become established *rafikis* or eventually fall out of the network, or, in some cases, remain in the network but as casual sales representatives who are not very active but also make sales from time to time.[12]

Kakute, on the other hand, engages in diffusing multiple technology products that are not necessarily their own commodities (i.e. the sales revenues do not go to Kakute directly). For example, the researcher conducted a number of interviews with technology adopters of solar PV home systems that belong to another SE, Mobisol, but were diffused by Kakute (interviews FU01-FU05, and FU09-FU10). The relation is that at the time Kakute incubated this SE and championed the diffusion of its products to Tanzanian rural and per-urban communities. Kakute used its knowledge of community needs and networks to diffuse these technologies, as it did in other projects (interview FS01). Another group of technology users associated with Kakute was a church group running a small hospital in a rural community in a rural district of Arusha region. The hospital is run by the local catholic church team, consisting of the parish priest (who is also the hospital director) and the church nuns, with additional physicians and nurses hired by the church. The entire hospital premises and equipment were run by a solar PV array with a large battery system, with the capacity of ~5 Kilowatts. The solar PV system was installed in the hospital by a German NGO through the active promotion and communication efforts of Kakute. As the parish priest tells the story (FU08, not verbatim):

> My initial contact with Kakute came through my need for energy in the hospital. We had a small generator and were still developing, so we needed something more…So I wrote a proposal for TANESCO and REA.[13] I was looking for a way and a place to submit the proposal, so I met director of Kakute (FS01), whom I knew. He introduced me to an

[12] The description of the rafiki network here is according to how it functioned up to the conclusion of the field research activities. The network underwent some changes afterwards, but were not reflected in the data collected from the field.

[13] Tanzania Electric Supply Company Ltd. (TANESCO), and Rural Energy Agency (REA).

> engineer from REA, and they both connected me to a German company which then supplied us with the solar system for the hospital [as a development aid project].

Soon afterwards, Kakute's director and the parish priest became interested in bringing solar home systems to the village households, since the village was still off the grid. Kakute teamed up again with the local church and introduced the community to the home solar PV systems that are offered by Kakute's partner and former incubatee, Mobisol. Through Kakute's promotion efforts and partnership they eventually succeeded in introducing the solar home systems to many households – estimated over 200 – in that community and the surrounding communities in Longido district (FU08).

As for TDBP, its diffusion activities consist of promoting biogas usage nationwide (but particularly to rural and agricultural communities) (interviews TS01-TS04, and KP05). For that it conducts a variety of activities (TDBP 2009) that include reaching out to regional governments, village committees and farmer associations, as well promoting biogas via national media (particularly radio). They also actively document experiences of biogas users to use as promotional material (TU01 and TU02). Additionally, TDBP partners with community and faith-based organizations to promote biogas among their memberships. The interviewees TS03 and TS04 represented two organizations, one faith-based and the other a local development NGO, that were partners of TDBP in promoting biogas and recruiting people to be trained as biogas digester masons.

Additionally, Biogas Construction Enterprises (BCEs) vary in their own diffusion activities. Each BCE is generally an independent business with its own possibilities. One BCE from Ngaramtoni (district in Arusha region) consisted of four certified masons who registered a company as co-owners. They run the company like a small cooperative, as they work on construction together and share revenues (interviews TSU07, TSU13, and TSU14). TSU07 said

about this arrangement (not verbatim), “We have a constitution, clear distribution of tasks and responsibilities. We work together and share the proceedings together…We like working together in this structure and don’t see each other breaking up any time soon.” This BCE has been in operation since the early patch of certified masons by the TDBP (2009), and has constructed about 200 biogas digesters up to June 2015. Interviewee TSU07 is also a biogas technology user himself, as most certified masons are, and has a 6-cubic meter digester at his house, which the researcher saw in person. By TDBP standards in Tanzania, this BCE is one of the successful ones with potential for growth, but that does not particularly translate into it being currently thriving economically. Yet this BCE is generally positive about its future in the biogas sector, provided that the sector will continue to grow in Tanzania. This BCE’s diffusion style is through the community network of the masons themselves and the word-of-mouth reputation they enjoy about their product and work by satisfied customers. On the other hand, a BCE in Same town, in Kilimanjaro region, has been more serious in promotional and marketing efforts (interview TSU09), which resulted in them constructing about 432 digesters so far, with larger sizes (such as the one that belongs to interviewee TU17 who purchased a 13 cubic-meter digester for her 300-pig farm). This BCE employs more masons (but only some of them are co-owners) and uses and pays promoters in the nearby villages and towns who get commissions for every customer they bring. Economically this BCE is stable but still needs to fight to maintain stability, since it needs to continue constructing and even increase construction rates. It however chose to register itself as a company limited by guarantee (similar to Kakute), which makes it technically closer to an SE than a conventional private business (TSU01, TSU10). Another BCE based in Mwanza, in the Lake Zone, is an outstanding example of aggressive promotion. This BCE constructed over 450 biogas digesters since 2012, and its manager, interviewee TSU08, is also a

biogas user at home (9 cubic-meter) and a certified mason. According to TSU08, this BCE is not a cooperative structure, has few co-owners and about 15 masons employed in total, in addition to 6 mobilizers (i.e. marketing fleet) and an advisor who takes care of strategic planning and accounting. This BCE extended its marketing approach to the point of producing video advertisements, putting them in DVDs, and paying local travel bus companies to play them on their screens while on the road. There are other BCEs that are not yet as active or successful in diffusing and constructing biogas digesters (such as TSU06 and TSU20, who have their BCE in the Manyara region, and TSU11-12 who have theirs in Arusha). These BCEs are active from time to time, and they have registered businesses, but they run other businesses and construction activities besides biogas construction since they cannot yet rely on revenue coming from biogas construction alone. However, these masons themselves are examples of users of biogas, most of them have their own digester at home and they are clearly glad that they have one.

Another case SE, Dorgo, focuses on diffusing their technologies through sales and partnership projects with agricultural R&D institutes (interview GS01, GSU02). In these projects Dorgo meets and consults with small-scale farmers about their technological needs and what Dorgo can offer them in terms of products and training. Some of the work that Dorgo does on promotion is voluntary (i.e. free of charge) and the other is direct sales or technical consultancies. Another case SE, Twende, hosts an innovation centre it uses to hold training workshops on appropriate technology for schoolchildren and young-adult innovators. The researcher witnessed some of these training workshops that Twende holds for schoolchildren, in which one of the co-founders (interviewee CS01) introduces them to basic principles of appropriate technology innovation, demonstrates some examples, and guides them into building their own projects or thinking of new ideas. Additionally, the researcher witnessed collaboration

between Twende and ECHO East Africa Impact Center in supporting young technology innovators who had ideas for developing and building appropriate technology products. Twende hosts these young innovators and allows them access to its machine workshop while the expert technicians of Twende coach them on various aspects of their design and fabrication. The researcher learned that this kind of training and collaboration is part of a multi-year agreement between the two organizations (interviews CU01, BS01 and BS03).

Institutional Support

Two case SEs were involved in institutional support activities: TDBP and Kakute. These activities included advocacy, resource mobilization and logistical and training assistance. For TDBP, its work on institutional support comes with its position as a nationwide initiative that has a commitment to both the public sector and large international donor agencies. TDBP works with national and regional governments to furnish an enabling environment for adopting biogas at a large scale and encouraging Biogas Construction Enterprises (BCEs), which are the social enterprise component of TDBP. It advocates and disseminates subsidies for BCEs based on their work, helps them register their businesses, and holds demonstrations and workshops for farmers and village residents about the benefits of biogas. It also lobbies regional governments to build pilot projects of biogas digesters in selected villages and public facilities (e.g. schools or hospitals). Additionally, TDBP works on resource mobilization to support BCEs and train and certify biogas masons. As described by the national programme coordinator, for carrying out the construction activities TDBP provides training and certification for masons who, after training and testing, can become independent contractors who provide the service of constructing certified biogas digesters for clients. These certified masons are responsible for constructing digesters up to standards and reporting their work in formal ways to TDBP testing teams (for

approval of quality) that guarantee clients good quality digesters and follow-up when needed. The masons are also entitled to some subsidy schemes to support their work and reduce the cost to the clients (thus making more clients interested). Masons are also encouraged, through TDBP and implementing partners (such as TS03 and TS04) to form biogas construction enterprises (BCEs) which can be registered as independent businesses that are in the trade of construction of biogas digesters. While the ownership (or management membership) of these BCEs is not necessarily restricted to certified masons, it happens to be the case that the majority of them are so (thus far) (TS01 interview). Being hands-on implementers, many of these BCEs end up operating technically as cooperatives, with co-owner masons being both equally the workers and owners of the business (such as the case of TSU07, TSU13 and TSU14 who together co-own a BCE). As a result, these BCEs are typically established and run by Tanzanians with technical certification and training in building and running a viable business. All in all, it is quite evident that the possibility of creating a viable commercial sector for biogas in Tanzania rests on the success of BCEs. They are the ultimate fruit of TDBP and it seems that the future of biogas in Tanzania will be as sustainable as BCEs will be. The small cooperative model of BCEs is a unique social enterprise experiment. As explained by the national programme coordinator, most BCE masons start by building their own biogas digester at their home, and so they are intimately connected to their product (i.e. both users and diffusers of the technology). The subsidy that TDBP provided BCEs (often per digester constructed) was decreased in 2014, and that decrease was felt by the BCEs – who mostly operate in rural areas – because, as many of them mentioned in their interviews, the usual clientele who are small farmers become reluctant to build a biogas digester in their farm since the capital investment cost is prohibitive for many of them. In an attempt to rectify, TDBP recently joined a carbon-offsetting scheme, in which European

businesses pay TDBP as a way to offset their carbon caps (i.e. paying for renewable energy production). Since TDBP has claim to over 12,000 biogas digesters nationwide (mostly small ones), through its network of BCEs, it is embarking on collecting data from all these digesters to account for their total contribution to carbon emissions' reduction to show credible documentation of renewable energy produced. It started in 2015 to develop a more detailed documentation system, and it is currently well on its way (interviews TS01, TS02 and XX02). The payments received from the businesses paying TDBP for carbon offsets are going to be used to improve the biogas commercial sector, including the continuation of some subsidies for BCEs to help them achieve financial viability over time. In other words, TDBP is providing a whole package of institutional support for BCEs: training assistance, resource mobilization, organizational development, and international networking.

On the other hand, Kakute has been strongly involved with TAREA to represent the growing renewable energy actors at the national policy arena. TAREA currently includes commercial businesses, SEs, NGOs and initiatives that seek to promote a supportive policy and infrastructure for renewable energy technologies in Tanzania in general. Their work involves lobbying the government and working with REA (Rural Energy Agency) to support and promote renewable energy solutions and foster a larger commercial sector for them, as a method of bringing energy to many parts of Tanzania (FS01 interview). The researcher witnessed TAREA's annual general meeting for the Northern Zone (Arusha, Kilimanjaro and Manyara regions) for 2015. Kakute hosted the office of TAREA in the Northern Zone, and the executive director of Kakute held the chair of the Northern Zone (i.e. regional representative and chair of Northern Zone general meetings). Additionally, Kakute performs other services for the renewable energy commercial sector, particularly in market intelligence and logistical solutions.

The researcher attended two workshops, one in Arusha city and one in the village of Terrat, Arusha, in which Kakute attended and presented as a renewable energy market intelligence expert in Tanzania. During the time of the field study Kakute was also active in training a number of certified biogas masons, in collaboration with TDBP, to coach them on establishing and maintaining their own BCEs, and was running a renewable energy market intelligence survey in the Northern Zone of Tanzania on contract with SNV and TAREA. So, Kakute's institutional support activities include advocacy, training assistance, and resource mobilization.

Overall, across the cases of this field study, all institutional support activities were present: advocacy, resource mobilization, and logistical and training assistance.

Technical Adaptation

Dorgo, GCS, Twende, Kakute and RafikiSoft demonstrated technical adaptation activities in their histories. Twende, for instance, works mostly with designing and building appropriate technology solutions to local challenges. Some involve adapting an idea of a machine or product and simplifying it for local affordability and utility. For example, a simple drip-irrigation kit, a small solar water heater, and bicycle-attached tools that use the pedalling mechanism, such as juice blenders.

GCS, on the other hand, was more involved in technical adaptation in its earlier years than it is now (AS10, AS20, AS06). In the beginning it used to produce and promote simple maize shellers and bicycle-mounted maize shellers, which were GCS' own design. The bicycle-mounted maize shelter made a good name for GCS for a while, but when the researcher was in the field GCS decided to discontinue selling the product, with the explanation that it was working on improving its quality so that they may introduce a better version in the future. No

specific numbers were given but a rough estimate of 200-300 of the these maize shellers were sold before discontinuation (AS20, AS01).

As for RafikiSoft, its flagship product was an ICT program and phone application that aids the rafiki network. This ICT product was modified to suit what a network of distributors in a developing country would need (DS01 interview).

Kakute received national awards in the late 1990s for its work on innovating and diffusing a number of agricultural technologies, including building a personal care products' industry from jatropha seeds (Kakute Ltd. 2007). Jatropha is a plant that is abundant in Tanzania, and Kakute was a leader in using it for making oils and shower soaps as well as generating biofuel from it (FS01 interview). Kakute's approach, as was explained to the researcher, was to help build a local supply chain for an industry that supports local farmers and manufacturers together, while also creating a local and regional market for natural personal care products. Later on, Kakute supported its former incubatee, Mobisol, to adapt solar home systems to make products suitable and affordable for Tanzanian households in rural and peri-urban areas. Such products included a system package that consists of a solar panel, balance-of-system components of a photovoltaic panel (wiring, switches, and a mounting system), a battery and power charger for household items. Additional optional items offered include LED light bulbs, portable lantern, and mobile phone charger. Kakute designed and co-conducted extensive field research to engage local communities in the technical adaptation process. Kakute's leadership explained to the researcher that they were confident that without community participation in the technical adaptation, the solar systems would not have been the success they have become (interview GS01, and field conversations with Kakute's leadership and clients).

By far, Dorgo seemed to be the most serious case of technical adaptation. Founded and headed by an agricultural engineer who has a talent for design, Dorgo started as a company that sells its own designs of agro-machinery products, modified to suit local Tanzanian conditions. Overall, Dorgo produced a variety of agricultural machines (GS01): 5 multi-crop and multi-operation machine (operated by a power tiller), a tractor-operated maize sheller, 3 forage choppers, 4 'mini maize shellers' (motorized with small engines), and 7 Cinva-ram Machines (soil cement block-making machines). Dorgo's power-tiller operated multi-crop processor (POMP) machine received an international award for innovation for development (GS01, GS02). It uses power from an imported power-tiller machine (powered by a generator) to make an attachment machine that uses the same generator, and the mobility of the power-tiller, to perform other functions, such as cutting grass and shelling and threshing crops (maize, rice, sorghum, etc.). The design was robust and efficient for smallholder farmers.

Additionally, Dorgo engages in innovation projects to improve and disseminate some traditional technologies and best practices in agriculture and agro-processing learned from various local communities. For example, Dorgo was involved in fabricating and modifying 45 low-land weeders, 10 oil-press machines, and doing some repair works for customers (GS01). Other projects combine improved local tools and modern techniques. As the head of Dorgo explained to the researcher, his knowledge and experience as a Tanzanian agricultural engineer allowed him to recognize how some existing local tools and techniques in agriculture are worthy of support and transfer from one region to another, or one community to another, as well as improving upon them instead of seeking to replace them with new machinery.

As for TDBP and the BCEs, and as explained earlier, their entire business was based on a biogas digester design that was modified locally, by CAMARTEC engineers, to suit Tanzanian

conditions. They developed a simple-yet-efficient design that requires no more than local building materials and a clear blueprint.

So, overall, the cases demonstrated involvement in the variety of technology localization activities: diffusion, institutional support, and technical adaptation.

ENGAGING EARLY ADOPTERS

The second question relating to the effectiveness of social enterprises as change agents asks whether in their diffusion activities, social enterprises demonstrate success in identifying and engaging individuals with the characteristics of early adopters of innovations. A set of questions in the interview guidelines served to capture this aspect. The clients of the SEs were asked how early and how in relation to the rest of their community or area, they adopted the technology in question. They were also asked if they held leadership or influential roles in their communities, and how they use those roles. Finally they were asked about their general experience with using the product and communicating its value to other community members, as well as their relation with the SE that diffused the technology and how they value that relation.

As discussed in chapter III, the literature on diffusion of innovations suggests that early adopters often happen to be persons of leadership in their community. Using their influence and communication networks in their communities, they introduce others to the technology(ies) they adopted, and persuaded some of them to adopt. Their levels of income are such that they were viewed as economically successful but not exceptionally wealthy in the eyes of the community. They also have sufficient resources to try new products or services beyond the basic necessities for the average household of the community. They could afford to take the risk of adopting a new technology with uncertain returns. Finally, they often – but not always – did not only adopt one form of technology that was uncommon in their community, but more than one (Rogers

2003; Ram & Jung 1994; Daberkow et al. 1998). The field data collected used these criteria to identify SE clients who relatively demonstrated such qualities, then reviewed how the SEs approached them and, then, what role they played in the diffusion process after they adopted the technologies.

Among all the staff of the SEs in this field study, only three individuals knew about the category of early adopters from Rogers' work. Two were GCS staff (AS10 and AS20). One of them, AS10, was cognizant of Rogers' work on diffusion of innovations, and the other learned about early adopters from the researcher in 2013, when the researcher was in Arusha for non-academic work. Similarly, the lead staff of Rafikisoft, DS01, was also relatively aware of Rogers' work and heard about early adopters from the researcher back in 2013. It might be reasonable to speculate that the AS10 lead staff of GCS may have benefited from Rogers' framework in the formulation of the rafiki network recruitment strategy; however she herself did not mention Roger's framework when interviewed. Therefore, generally speaking, the case SEs did not have a particular strategy that overtly specified targeting 'early adopters'. Their diffusion models were not designed literally that way. That however did not mean that they were not effective in engaging early adopters in reality. The field data indicated that notable clients of SEs who were among the first adopters of their products and services also demonstrated qualities of early adopters described in the diffusion literature. For example, they held positions of community leadership, i.e. played a leading role in village council, farmers' association, women association, church or mosque, commerce, etc. Additionally, a number of adopters that were interviewed initially for their adoption of agro-processing machinery turned out to be also early adopters of biogas digesters and solar PV energy home systems, or vice-versa (such as GU02, TSU11, GU05, AU06 and FU08). Additionally, a number of such interviewees told us about

their future plans of adopting or improving more technologies – not necessarily provided by the case SEs – that aid their livelihoods (such GU02, GU05, and AU06).

As shown earlier, GCS has a routine approach to introducing themselves and their products to new communities and recruiting potential *rafikis*: they speak to the leadership of communities first. GCS approaches each new community by either speaking to the village council or chairman first, or introducing themselves to the leaderships of established community associations (e.g. SACCOs, farmers' associations, etc.). In such communities some of those same leaders become interested not only in being among the first to try the new technologies offered by GCS, but also in taking the route of training and commissioning to become a *rafiki*. Given the criteria of early adopters, it is likely that there exist early adopters among such individuals from communities. Some of the clients who were interviewed fit the description (such as AU03 and AU06). For example, AU03 is a lady who is a *rafiki* with GCS. She joined the rafiki network when she was nominated by her local SACCO (Small Saving and Credit Cooperative) in Ngaramtoni, Arusha, where she was a leading member. She was among the first in her community to adopt the products of GCS and she also sold them by demonstrating their use to her neighbours in her own household. Within a year she was influential enough to make many members of her community adopt the new technology (solar lanterns). Another examples is AU11, a lady who resides in the Morogoro region who joined the GCS microfranchising network (as a *rafiki*) after she herself adopted the solar lantern products for her home. She is also schoolteacher and businessperson. She used her own network (i.e. school teachers and parents) to promote the products.

Most technology users explained that the way they heard about GCS for the first time was through either their own village chairman calling a meeting or through some of their

community organizations such as women or village SACCOs spread all over Tanzania. For example, interviewee AU03 heard about GCS for the first time when she was invited by her local SACCO in a village near Arusha town, in which a field officer from GCS introduced the company and its products, with some demonstration of the agility and multiple uses of the solar lanterns (the researcher has attended some of these introductions). The field officer would explain the benefits of the product as well as the financial returns (such as the payback from paying monthly for kerosene lamps while a 3-month payment for a solar lantern will last for more than a year of a good and portable product to provide light). Interviewee AU03 also said that the field officer explained to the audience that the company is looking for local partners as *rafikis* who will be given training and advances to sell the products to their neighbours and communities. She became interested in the product itself and saw the potential of selling it to her neighbours. She bought one of the solar lanterns, and over time ended up buying several of them (all functioning at the same time), and she also became one of the *rafikis* with good sales. Others, such as AU06, said that he was introduced to GCS products and the rafiki network in a similar way but through a village meeting – i.e. by GCS holding a village meeting in coordination with the village chairman or council. Others, such as interviewee AU04 said she was introduced to the solar lantern product directly through a door-to-door field visit by GCS staff. In these visits – which used to be more frequent in the earlier period of 2013 – GCS staff spend time with smaller groups in communities to simply introduce the products, their benefits, the warranties and the installment payment possibilities. AU04 said she liked the product, purchased one, and after some time she became interested in becoming a *rafiki* herself.

Kakute uses a similar approach to GCS, with regards to introducing themselves first to the community leaderships, such as the village councils and district governments. But Kakute

has been diffusing technologies for a longer time and the leadership of Kakute have a larger network of acquaintances and friends in communities, district governments, village councils and community organizations. In that sense one can say that Kakute's social capital is larger, and it uses it often to promote technologies effectively. Not surprisingly, some of Kakute's clients who were interviewed also displayed characteristics of early adopters (such as FU01, FU03 and FU04) as well as one case of an influential innovator (FU08). For example, FU08 is a catholic priest that the researcher met in a completely off-grid community, located within the borders of a national park. He successfully partnered with Kakute and mobilized his church community, and the surrounding community, to do as he did and adopt solar PV home systems with rent-to-own payment schemes. Also, and more as an innovator than an early adopter, he also succeeded in securing support and funds to supply a small solar PV array system to provide energy to a local health centre, which later grew into a small hospital, administered by the church. This priest is a highly educated person (with doctorate of philosophy from a western university) whose work revolves around rural communities in which he lives for years at a time and builds communities of faith.

As for Dorgo, it currently has very little communication and marketing activities, which can explain why most of the Dorgo clients we interviewed (4 out of 6) are highly educated individuals with agricultural expertise. Among Dorgo's few clients there appeared to be at least two outstanding early adopters (who also exhibited characteristics of innovators to some degree, as they were also outstandingly passionate about various innovations, even ones that the rest of their communities never experimented with): GU02 and GU05. However one cannot say that Dorgo identified and engaged them, but rather they approached Dorgo with clear demands. For example, GU02 is a retired veterinary doctor, who also used to be a senior official at the

agricultural department of one district in Kilimanjaro, was interviewed as one of the technology adopters of agro-machinery products from Dorgo. We discovered that he was also an early adopter of many new technologies to his community, and has been actively influencing others to adopt them, such as biogas digesters and solar energy systems. Additionally, as innovator, he was the first in his community to adopt modern, simple horticultural technologies that he learned from Israeli agricultural and water management innovations.

As for Twende and Rafikisoft, they did not appear appropriate for this line of inquiry – the aspect of identifying and engaging early adopters. Twende did not yet have an established list of adopters of its technologies, as explained earlier, and Rafikisoft had no more than two clients, one of which is GCS itself.

Some of the BCEs are quite active in marketing and promoting biogas digesters, with degrees of success. However most of the initial work of promotion and education about biogas in most communities around Tanzania is carried out by the TDBP, which in turn identifies the first clients. As for TDBP and how it approaches biogas diffusion, the national programme coordinator gave an elaborate description in his interview (TS01):[14] They use awareness campaigns (flyers, live demonstrations, PowerPoint demonstrations, gatherings, TV and radio, etc.). They make announcements that we are now a team of biogas technicians coming to the village to introduce the technology. They also arrange to build a demonstration plant with one of the innovative farmers (identified by the local leadership). Once the plant is ready, they use it to demonstrate to others the usefulness of the plant. They share the cost with the farmer (we share about 1/3rd of the total cost of the digester). The innovative farmer himself/herself has to be

[14] As explained in the methodology chapter, there were virtually very few and short direct quotes from the interviews, since they were not recorded in audio or video but written down by the researcher during interviews. This method of interview was deemed safer for the participants to avoid the risk of existing records of them speaking directly about their supervisors or community leaders.

willing to invest in this. He/she is given a bill of quantity and once he gets them and the pit is dug by him, a technical building team comes and constructs the plant. Then the farmer is trained on how to manage it and is monitored and supported. Once the plant starts producing, TDBP calls on other farmers to come and see for themselves…. [As for the biogas mason] he/she goes through a certification process, in which after he is trained he must build his own biogas plant (in his/her home, but if he/she does not have cows it can build for a neighbour for example). After it is finished the technical team comes and assesses—if it is well done it is certified, and then the mason is required to build another biogas plant for surety (usually built for a politician in the region or something). Once that second plant is built and assessed, and passes the certification, the mason himself becomes a certified biogas mason. This way TDBP and the certified mason are quite sure of his/her abilities to construct plants. These are usually masons by skill, so TDBP upgrades their skills for biogas plants. The mason then becomes a running business and can make money by constructing plants for others and having them certified by TDBP. Still the technical team of TDBP checks the quality of all plants. All plants in the country are assessed by the program's technical unit and accounted for, so every single plant is known and TDBP has a GPS map for them.

It seems that, without naming them ‘early adopters’ or ‘innovators’ per Rogers’ terminology, TDBP is seeking to attract innovators and early adopters in communities and nationwide. Some of the interviewed BCE co-owners fit the signs of early adopters, such as TSU08 and TSU11. For example, TSU11 is a certified biogas mason who co-founded a BCE in Mwanza. After joining the biogas mason certification program, and constructing his own biogas digester at home, he co-founded a biogas business with another certified mason and then widely promoted biogas technology and completed the construction of over 450 digesters in 3 years. In

his promotion of biogas he used video advertisements produced by his BCE. His company diversified its activities in promoting other emerging technologies, such as water harvesting systems, and remained financially profitable.

Not all the early adopter characteristics were found in each adopter, but a sufficient combination of them, when applicable to individuals, were found among the adopters interviewed. It was found that communities covered by this field study (see Appendix V) in which many demonstrated common characteristics of early adopters, had rates of adoption that were considered relatively high by both the community and the SE staff. Particularly, if the early adopters themselves were satisfied with the product and with the SE in question, they reported that they persuaded a large number of other community members to adopt it. Those were communities such as Longido district (Arusha), Ngaramtoni (Arusha) and Turiani (Morogoro), in which technologies of solar power home systems and solar lanterns were introduced by Kakute and GCS.

Early adopters in many communities played an important role in the diffusion process. Some of them were targeted and recruited early by the SEs. Others became interested and involved due to peculiar circumstances, such as hearing about the new products and services and seeking to try them (such as GU03 and GU05 with Dorgo and FU08 with Kakute), or being introduced to the social enterprise and their products or services due to their official title (such as being the village chairman, district officer, known merchant or farmer in the area, etc., such as FU01 and AU12).

In summary to this section: according to the sample of SE clients we interviewed, a number of people with the characteristics of early adopters were engaged in the diffusion process at earlier stages, in most of the case SEs (GCS, Kakute, TDBP and Dorgo). They have shown to

be influential in increasing the rate of adoption in their respective communities. However, it was not generally clear whether the case SEs actually consciously targeted early adopters and recruited them based on an intentional strategy of identifying and engaging early adopters.

The data from this study demonstrates that SEs do engage early adopters but it is not clear that they do so consciously – i.e. by intentionally targeting such individuals. If we apply Rogers' terminology rigidly, it will be difficult to say that any of the case SEs had an intentional strategy engaging early adopters. However, we can see from the data demonstrated earlier, that SEs have learned over time that certain community members are potential assets to their teams. They are more likely to adopt the technologies earlier than the rest, and some of them are quite influential in their communities if they are persuaded to adopt and become satisfied with the experience. The SEs of GCS and Kakute, as well as some BCEs and the TDBP itself, have shown that they think in such ways and that such approaches bring some favourable results to them.

SATISFACTION OF RESPONDENTS WITH THEIR TECHNOLOGY

The third question related to the effectiveness of social enterprises as change agents asks whether clients and partners of social enterprises give overall favourable accounts of the technological change that they experienced.

Out of the 108 interviews, the majority were asked to respond to likert-scale questions (besides other qualitative elaborations) about their experience with the technologies they adopted or promoted. Seventy-seven of the total number of interviewees responded to those questions. Table 7 shows a summary of their responses (with more details in appendix VII). The questions examined perceived qualities of the new technological products and services, namely: their

relative advantage (compared to locally existing alternatives), compatibility with existing values and practices, simplicity and ease of use, trialability and observable results (Rogers 2003).

Table 7 Satisfaction of respondents with their technologies*

Responses / Criteria	Positive	Neutral	Negative
Relative advantage	73 (out of 77 responses)	3	1
Compatibility (~)**	70 (out of 77)	3	4
Simplicity	66 (out of 77)	7	4
Trialability	55 (out of 77)	11	11
Observability	Majority observed benefits of technologies within a few months. Few observed benefits over years or immediately.		

*Measures of satisfaction are elaborated in appendix VII.
**estimated average of 3 questions. See appendix VII.

Interviewees, especially the clients and partners of SEs, were asked about their relative satisfaction with the technologies and the way they are diffused in their communities through the efforts of the social enterprises. As a second measure the researcher made an independent assessment of the general economic and marketing performance of the case SEs. In the interviews technology users were asked questions about the performance of the SEs particularly regarding how they introduce the technology and engage the target communities to spread the product. The questions generally were the following (with variations): “how did you first hear about the social enterprise and its products/services?”, “can you describe the marketing approach of the social enterprise, as you understand it?” and “from your perspective, recount the advantages and disadvantages of the communication and marketing approach of the social enterprise.”

One fundamental factor that is essential to the success of the diffusion effort is the technology itself. If the technology product or service itself does not prove to be effective, in good quality and meeting serious demands in the community, it is highly unlikely to be adopted. In the interviews with adopters, some of them had unsatisfactory experiences with some products

or services (not necessarily those of the case SEs), and they communicated their dissatisfaction to other members in their communities. For example, in interviews with GCS clients and *rafikis* in the Morogoro region, they spoke about another brand of solar lantern that was already in the market before GCS opened its Morogoro branch (especially AU11 interview). Apparently, those lanterns were of lower quality, durability and warranty than the ones GCS provided, so users were not generally satisfied with them. When GCS lanterns were diffused in Morogoro initially, people were suspicious, but the demonstrated quality, and the warranty guarantee, eventually persuaded many. However, the competitor lanterns are lower in price than the ones marketed by GCS, so some people still buy them because of affordability (AU11 interview).

The responses of the technology users who were interviewed though GCS – AU01 to AU16, (see Appendix VI) – were generally consistent. Their peculiar status as *rafikis* should be considered however, as they did not necessarily speak only as users of technology but also as business partners of GCS. That role may make them partial in some ways, as they have vested interest in the good reputation of the technology products. The users of the GCS products generally agreed that the diffusion efforts of GCS had good results, and that generally due to GCS the community now knows about the products and many have adopted them, especially those who could afford them (as for some community members they were still unaffordable). However, there was a consistent criticism by most of the users interviewed – AU01 to AU16 – regarding the price of the products, particularly the solar lanterns, and the pace of GCS logistical operations. They said that the prices of the products are still unaffordable to many members of their communities, and they also said that GCS field officers take a long time to respond to their demands for more products to sell or to receive and fix some recalls as per the warranty. From their side, GCS staff explain that running a fast-response logistical operation is very difficult,

particularly with the limited resources they have (e.g. limited car fleet and field officers with vast distances and difficult terrains to cover). Nonetheless, when asked to rate the impact of GCS in their community as far as introducing a technology with perceived advantages, the respondents were generally quite positive. They were satisfied with most products (especially the solar lanterns) and confident that they will remain popular in their communities.

There were some criticisms among the adopters about the performance of GCS. Some early adopters reportedly pulled back support for the products or services or the diffusion efforts. This study could not make contact with those former clients because their connection with GCS was severed and the researcher did not know how to locate and contact them, but they were generally acknowledged by the GCS staff. Some active clients of GCS also have some grievances that they openly shared with GCS and the researcher. Interviewees AU11, AU13 and AU16 summarized the essential criticisms of many *rafikis*. They contended that *rafiki* commissions are generally low and discouraging, especially that the sales are also relatively low in volume. The low rate of sales for each *rafiki* is sometimes due to the policy of GCS of having multiple *rafikis* per community, or in close proximity to each other, which may help the proliferation of GCS products in such communities but also makes *rafikis* compete with each other and have a smaller potential market. Additionally, the interviewees addressed some problems with product replacement costs. When a customer calls a *rafiki* to report a defective product, the *rafiki* is expected to get that product and exchange it or fix it with GCS, according to the warranty, then return it to the customer. The *rafiki* bears the cost of following up with that customer, getting the product, taking it back and bringing a replacement, but without any change to their commission of sale (per product). There is a cost of time and money spent in this process that is born by the *rafiki* alone, which is seen as unfair by many *rafikis*. The inability of the SE to

follow up on complaints promptly, due to shortage of resources, eventually renders dissatisfied clients, and those speak to their neighbours. There were also complaints about products such as the bicycle maize shellers that led to a general discontinuation of sales until the recurrent technical problems are fixed. There were also complaints about the functioning of a solar lighting system (4 lights and phone chargers, one solar PV panel). Some users complained that their systems after being fully charged sometimes operate for far less hours than advertised. Also, a new version of a popular solar lantern received multiple complaints about energy inefficiency.

The technology users who were associated with Kakute varied in their responses because their experience with Kakute was not as uniform (FU01 to FU10 interviews). The users of Kakute were not all direct recipients of technology products or services from Kakute, since Kakute's profile, unlike GCS' or Dorgo's profile, is not dominated by direct sales of products to communities (as explained above). Therefore, the users of technology associated with Kakute who were interviewed were a combination of direct beneficiaries of a renewable energy project of Kakute and members of communities where Kakute conducted promotional work for the products of one of its incubatees. Despite the variety of users associated with Kakute it is the SE that received the highest collective praise from technology users. The researcher met 15 of those technology users in the first group (FU06-FU08, and FU09 and FU10 as group interviews). In their interviews, the first group of adopters described how they were hesitant about trying solar home systems, but with the persuasion of Kakute and the church they decided to try them. Currently they say that they look back to their lives before solar power and they see big differences. Some of the benefits they mentioned were (FU09): a) Some house-shops can remain open after sunset for more hours, and that helped improve their businesses; b) School kids have

more time to do their homework in the evenings; and c) Since this area is close to a national park, they used to have problems with animals, such as elephants and hyenas, crossing their communities, especially at night, which was obviously a problem. Solar lights in households at night reduced these occurrences.

The second groups of Kakute clients (FU01 to FU05), who were from another district closer to Arusha town, expressed a particular appreciation for the sensitization work that Kakute did in their community to introduce the solar home systems. Kakute's approach in this community was to approach the village council and chairman, persuade them with the potential benefits of solar energy, and convince them to hold a village meeting in which Kakute's director spoke directly to the community members about the product and the rent-to-own scheme. Eventually, the village chairman was among the first to adopt the system in his own house (FU01 interview), and he continued to be appreciative of the work Kakute did in diffusing the new solar power technology in his community long after Kakute was no longer active there. Overall it was easy to conclude that Kakute enjoys a solid reputation among its clients and partners. However the one thing that a number of its clients pointed out (particularly FU01, FU05 and FU08) was that Kakute is under-funded and its own resources are quite limited, which affects their capacity for delivering higher quality services.

The researcher did not have sufficient access to the technology users and clients of either Twende or Rafikisoft, to know their assessment of the technologies and the performance of the SE. The reasons for that are that Twende was not yet active in selling or diffusing products or services to communities (as it dealt more with training and innovation support during the time of the field study), while Rafikisoft only had one accessible client, GCS, which could only provide

a one-client perspective (however, GCS has been intimately involved in this ICT product since it was originally designed for its *rafiki* network).

The last SE for which the researcher was able to speak to a representative sample of clients was Dorgo. Dorgo is one of two smaller SEs (the other is Rafikisoft) but it is significantly productive, and it also focuses on agro-machinery technologies (while the others mostly focus on sustainable energy or appropriate technologies). Six clients of Dorgo, located within the two regions of Arusha and Kilimanjaro, were interviewed (interviews GU01 to GU06). All of them were quite comfortable in saying that the technologies they used from Dorgo are of good quality and even comparing them favourably to machines imported from China, India or Brazil. Four of Dorgo's clients were agricultural experts: an engineer with an agricultural institute (GU01), a retired veterinary doctor and head of agricultural department in his district (GU02), an emeritus professor of Agricultural science (GU06), and a manager/trainer in forestry at another university (GU05). Each one of these Dorgo clients knows agricultural technology well, besides having qualities of early adopters or innovators, hence their feedback carries more weight than the 'regular' clients. Almost all four clients agreed on three things: that the quality of Dorgo products is praise-worthy (albeit there's room sometimes for improvement or modification); that the prices of its products are generally not accessible to the average farmer household (unless with alternative payment methods or with sharing schemes among multiple farmers); and that Dorgo's clear weak points, that require immediate attention, are its communication and marketing. They even requested the researcher to relay to Dorgo that they could do much better if they improve their communication with clients and potential clients (starting from being more prompt in responding to clients) and implement a marketing technique. All four clients said that the way they heard about Dorgo was through coincidental conversations with friends or

colleagues who happened to know about the business activities and engineering skills of Dorgo's manager. Dorgo itself responded to these concerns (as the researcher relayed them) by assuring that they are planning to have communication and marketing that is more proper in the near future as the company becomes more stable. However, it is worth noting that in another example (interview GU03) Dorgo took the initiative to lend one of its machines to a rural community association so that its multiple members can use the machine on their small farms, in hopes that they will give feedback to Dorgo later or become interested in collectively purchasing the machine.

Overall, although the sample is not robust or conclusive for descriptive statistics, a trend can be reasonably assumed that clients of the case SEs had generally positive feedback about their experiences with the technological change brought by the SEs. Their satisfaction was not complete, but they were more satisfied than dissatisfied. They suggested ways of making their experiences better but had no regrets about the experiences.

CHAPTER SUMMARY

Table 8 summarizes the results of this research regarding the three sub-questions assessing the relative effectiveness of the case studies in technology localization. As indicated, activities of technology localization seem to be evident among the cases in general, but without each one being active on all localization activities equally. With regards to engaging early adopters, a visible number of the cases demonstrated that they have early adopters among their clients. As for satisfaction of clients with the technological change experience, the results are favourable in general.

Table 8 Cases and signs of effective localization						
		Localization activities			Engaging early adopters	Satisfaction of clients with change
		Diffusion	Institutional Support	Technical Adaptation		
Cases	GCS	a	b	b	a	a
	Kakute	a	a	a	a	a
	TDBP (& BCEs)	a	a	b	a	a
	Dorgo	b	•••	a	b	a
	Twende	•••	n/a	a	•••	b
	Rafikisoft	b	n/a	a	•••	•••

Legend: a = active involvement; b = somewhat involved; n/a = not applicable; ••• = indistinct/inconclusive info.

Tanzania has a vibrant scene of emerging social enterprises as agents of technology localization, with relative successes and setbacks but a persistent presence. Interviews with adopters of new technologies provided by the case SEs revealed variations and similarities in their stories in terms of how they adopted the technologies.

Two main technology types are the focus of the case SEs in their technology localization activities in rural Tanzania: sustainable energy technologies and agro-machinery. Sustainable energy technologies include solar PV, biogas, and biofuel efficiency. Satisfying technologies may not guarantee successful adoption, but unsatisfying technologies are very unlikely to be successfully adopted.

The findings demonstrate that SEs can be effective agents of technology localization in Tanzania. The cases demonstrated involvement in the three activities of localization: diffusion, institutional support and technical adaptation. Through their diffusion activities, most of the case SEs were able to engage early adopters in diffusion activities. Early adopters in such cases played key roles in diffusing the technologies in their respective communities. And, finally,

technology users – the clients of the SEs – generally had few complaints about the technological products themselves. Most of them viewed the technologies positively and acknowledged the convenience they brought to their lives. There was less consistency in opinions of technology users about their relationship with the SEs, but these were also balanced and generally positive.

Are the findings of this research applicable to other East African countries? The response is a conditional "yes". Some of the SEs explored in this study also operate in some capacity in other East African countries (such as GCS in Kenya, and Kakute in Rwanda for some consultancy work), or have counterparts there (such the TDBP equivalents and partners in Uganda and Kenya). Rural conditions in East Africa are often comparable across national borders. Ultimately however it would depend on the national policy and attitude towards the private sector. Overall, there are legitimate prospects for SEs to contribute to development efforts in African societies, where possible, including technological change efforts. Due to their inclination for innovation, their decentralized nature (compared to corporate businesses for example), and their social-economic balance and perceived 'realism in idealism', SEs might succeed where the conventional private sector has failed.

The big differences in socioeconomic and environmental contexts between East Africa and North America (and Western Europe) makes the use of the term 'social enterprise' very different or almost irrelevant in Tanzania, while social enterprise models – i.e. social mission with business model – exist and will likely continue. In Swahili there is not even an adequate translation of the term social enterprise (yet) despite the proliferating number of SEs and the continuing use of the term in English and in international communication (between SEs in Tanzania and the outside world). Local SEs are also either officially registered as private businesses or NGOs (i.e. no legal category of SE).

CHAPTER V: ADDITIONAL FINDINGS

This chapter deals with the additional and incidental findings from the field study related to the activity of social enterprises as change agents. These findings were either complementary to the main questions (i.e. non-incidental but secondary) or were not anticipated in the original research design and literature review but were observed and recorded by the researcher and are included here as extensions of the research findings.

MODELS OF DIFFUSION

During ten months of field research, the researcher observed that there were different models of diffusion being practiced. Models of diffusion describe how SEs introduce the technology to the market and make it possible to find adopters in the targeted rural communities. This observation could not have been reached before having an intimate look at how the case SEs work in Tanzania. Being unconventional to their contexts, these models show a side of SEs' innovativeness and flexibility in fulfilling their missions. Such observation could be used as additional empirical support to the argument for the potential of SEs as effective in filling gaps in development that other agents of technological change did not fill. The innovative use of these unique models of diffusion may differentiate SEs' approach to technology localization from the classical development actors such as NGOs, CBOs and state sponsored agricultural extension services. Three diffusion models currently used by the case SEs can be identified.

The Microfranchising Model

Microfranchising means that companies and organizations team up with local community members or groups with entrepreneurial tendencies, to reach far and wide into remote areas,

where their products (and services) are most needed (such as off-grid energy technologies, agro-business services and machinery, microfinancing, etc.). Instead of establishing branches everywhere, SEs 'franchise' their brand and products or services to local individuals (or groups) in the villages and districts. It is called microfranchising because it follows the traditional business franchizing protocol but is more limited in size and representation, and more flexible in contract of partnership. Microfranchising has been defined as "a development tool that leverages the basic concepts of traditional franchising, but it is especially focused on creating opportunities for the world's poorest people to own and manage their own businesses" (Lehr 2008, 3).

Local entrepreneurs become business partners who have access to training, guidance, product advances, and commissions by the larger partner company (in this case the SE). The incentives for local micro-entrepreneurs are often doubled in such deals: they are able to diversify their own businesses and they also gain access to professional training and association with larger business entities with expected wider networks, knowledge and relatively higher standards of commodities and service. The SEs, on the other hand, expand their market significantly and become accessible to consumers wherever they are. This approach is effective for last-mile distribution of small products with minimum technical maintenance requirements. This is how GCS is using the rafiki network in its last-mile distribution model. In this model, microfranchising seeks to overcome two obstacles. The first is the infrastructure obstacle: the deficiency of transportation and communication infrastructure in a country such as Tanzania – especially in rural areas – makes last-mile distribution very difficult. Yet, such conditions also make last-mile distribution very critical for the success of businesses that target rural clients. The second obstacle is the marketing obstacle. It is a huge task for a company to introduce itself and its products to the entire region or country given financial and logistical limitations. It is more

efficient marketing for companies (or SEs) to focus on targeting and properly-training selected individuals (and entities) who have initial interest and capabilities, and who will then carry out the marketing activities within their own communities.

Besides overcoming the obstacles above, two good 'triple bottom line' values can be created by the microfranchising model. According to Lehr (2008) and GCS staff interviews, microfranchising fosters two important values. The first is sharing economic gains: the local micro-entrepreneurs get margins from sales, so there is a level of immediate profit sharing with local community members. The 'brand sharing' between the company and local entrepreneurs also makes the brand more organically familiar to communities (i.e. they associate the brand with some of their own members). The second is increasing local business capacity: through training the local entrepreneurs learn not only how to market and sell the new products, but also techniques of managing and improving their businesses. Valuable knowledge and skills are gently deposited in the communities. For example, most of the rafikis of GCS interviewed in this study said that they gained general business and marketing skills that they can use in running their own business ventures regardless of the products they sell.

As mentioned, an example of microfranchising in Tanzania is the rafiki network of GCS. The rafiki network consists of local village entrepreneurs who are both customers and distributors for GCS. Some of the *rafikis* registered in the network were not necessarily ‘active’ because they had discontinued making sales for a considerable period of time. An entrepreneur in this network is referred to as a *rafiki* and they are effectively a representative of GCS in their respective community. *Rafikis* can make sales on behalf of GCS, market products of GCS, and communicate with GCS regarding any customer inquiries (including fixing or replacing some products according to their warranties). All the GCS products a *rafiki* sells have a margin for

them as well, and they also get the products from GCS at reduced prices. Another noteworthy feature of *rafikis* is that they are often both users and distributors of the technologies diffused by GCS. Many of them purchase solar lanterns and other products for their own households, and they are often among the first purchasers in their communities. Many of them choose to become *rafikis* when they recognize a good opportunity for diffusing new technologies in their community and benefiting from that; i.e. they tend to be entrepreneurial. To some extent this observation may further confirm one of the main findings of the research: many *rafikis* tend to be early adopters not just of the technology but also of the microfranchising model. So there are multiple innovations diffusing at the same time.

Sector-Enterprise Cultivation

The sector-enterprise cultivation model of diffusion was embraced by the TDBP for enhancing the biogas sector all over Tanzania. The name and the description of the model are a result of synthesis from field observations and information provided in interviews and program documents, such as interview TS01 and the TDBP Programme Implementation Document for Phase II (2013). With this model, a new technology is introduced together with the technical standards and support for the creation of micro and small enterprises. Biogas Construction Enterprises (BCEs) are a result.

In this model of diffusion the entire biogas technology sector is diffused to rural communities in conjunction with many home-grown SEs: the BCEs; particularly the cooperatively mason-owned ones. While the umbrella organization is a nation-wide program, a national initiative with both international and local funding, the proliferation of the biogas technology in rural Tanzania rests on masons who joined the training course, graduated and

started their BCEs. Also, as shown earlier, the masons also have a peculiar position being often both users and active diffusors of the technology; with a number of them fulfilling the early adopter criteria (similar, in ways, to the *rafikis* of GCS).

Business-Technology Incubation

Business incubators are not new anywhere in the world. Incubators are known to take infant ventures (or business ideas) and provide space, coaching, linkages, market intelligence, and a path to graduation as free-standing firms. Incubators around the world have a record of good business support and job creation in their communities. Overall, data says that incubated enterprises are more likely to succeed in the market after graduation than nonincubated enterprises. According to the Adrian Innovation Center (2015):

> "As of October 2012, there were over 1,250 incubators in the United States, up from only 12 in 1980. [There are] estimates that there are about 7,000 business incubators worldwide. The incubation model has been adapted to meet a variety of needs, from fostering commercialization of university technologies to increasing employment in economically distressed communities to serving as an investment vehicle."

In Tanzania, the incubation approach to support early-stage enterprises seems to have recently started to draw more attention, and most of the organizations that offer incubation services currently are public education and PTIs (such as universities, SIDO, CAMARTEC, etc.). In Tanzania business-technology incubation is a mechanism for technology diffusion by SEs. An example of business-technology incubation in Tanzania is Kakute as incubator of solar PV enterprises. For 2 years Kakute successfully incubated a younger SE, Mobisol, which delivers small solar PV power systems for average Tanzanian households (especially in rural and off-grid areas) on a rent-to-own program, a program which, in its own right, could be described as another social enterprise strategy (not a strategy of Kakute itself however, but the incubatee of Kakute which was not a research participant). Clients pay for the solar power service on monthly

basis in installments, and after payment of the system's full price over time they become owners. Kakute used its established network and its social and technical expertise of promoting new innovations to build a good customer base and brand awareness for its incubatee (FS01 interview). According to their website (2017), “Since its creation in 2010, Mobisol has installed over 70,000 solar home systems on households in Tanzania and Rwanda.” This is not the first project Kakute has incubated with nationwide impacts. An older project with a nationwide impact involved the establishment of multi-businesses that were based on the agro-processing of jatropha plants in Tanzania (e.g. oil, seed, and soap products from the plants) (FS01 and FS02 interviews, VCD Training 2004, and Kakute 2007). Given Kakute’s experience, and unique place as one of the oldest Tanzanian SEs, its incubation ventures seem to be a noteworthy approach to technology diffusion by an SE; particularly since this model of diffusion was key to the popularization of jatropha oil soaps and biofuel, and the emergence of one of the largest renewable energy SEs currently in Tanzania. It can be concluded that Kakute played a large role nationally as an agent of technology diffusion (and localization in general) through the incubation model.

These three models of diffusion were identified in the cases included in this research. There could be other models that this study did not uncover. There were also, of course, as mentioned earlier, other conventional models that were used, such as direct sales and marketing, using local retail stores as distributors, and general educational and promotion activities.

OTHER FACTORS INFLUENCING EFFECTIVENESS

In the field, additional factors were found to influence the effectiveness of SEs as agents of technology localization in Tanzania. While these factors did not directly affect the activities of

technology localization, per se, they were nonetheless important for the survival and growth of the SEs themselves so that they could continue their localization work.

Economic and Organizational Survival

Surviving economically is one of the challenges our cases are generally facing (except for some BCEs which seemed to be thriving at the time of the field study). During the time of the field study most cases were surviving by various means, and neither they nor their clientele were pessimistic about the future.

GCS staff, for example, were consistent in their expressions of confidence that their SE is well on its way to growing and expanding to more regions in Tanzania, and perhaps someday reaching outside Tanzania. Currently they have a few operations in Kenya, even some *rafikis*. The CEO of GCS described its mission concisely as "To improve the lives of one million households through quality, affordable technology". Kakute's staff is also convinced that there is much work to be done, particularly in the efforts of localizing sustainable energy technologies, and Kakute has tremendous experience in doing that in Tanzania (FS01 and FS02 interviews). The TDBP coordinating team and the BCEs are also optimistic that biogas and bioenergy is on the way to becoming a large commercial sector in Tanzania (TS01 interview). Dorgo also sees the future of agro-machinery strongly tied to any possible genuine development and economic growth in Tanzania.

Organizationally, these SEs appear to cultivate a visible sense of belonging among their staff. We have seen cases where the staff of one organization have a significantly active social network among themselves (such as the case of GCS) and in which they take pride. In interviews with AS01, AS04, AS06, AS20, they specifically mentioned the friendship and social camaraderie among the staff of GCS as one of the advantages they feel about their work. As for

Kakute, the researcher observed that the staff act with each other like family, with the director as an easy-going parent figure. There are however signs that some staff face morale fatigue and exhibit levels of work discipline that would not be generally acceptable in for-profit conventional business organizations (no reference to interviews will be mentioned to minimize social risks on participants). Such are perhaps partially explained by the lower salaries and career prospects in these SEs compared to expectations on the conventional business side. Both GCS and Kakute managements expressed frustration with the difficulty of recruiting and retaining qualified staff for critical technical and managerial positions. They appreciate most of their current staff, but they have stories of losing qualified staff to more promising job offers as well not being able to replace them with equally qualified ones.

Another challenge to the success of social enterprises in Tanzania is start-up financing and its effect on long-term sustainability. The cases of this study, and the other SEs that we were made aware of but which did not officially participate in the research (such as M-KOPA, Off-Grid Electric, and others), suggest that a majority of the SEs that achieve a reasonable level of economic and organizational vitality are, or have been, financed by either foreign capital or donors. The financial support received by SEs has been often in the form of start-up funding and with expectations that the recipient SE will eventually be financially self-reliant based on its own core activities. However, when this field study took place (2015) most case SEs were not yet self-reliant, although some of them were established since 2009. The only two SEs that could be described as financially self-reliant were Kakute and Dorgo. And while RafikiSoft is also self-reliant it is mostly due to the personal pockets of its co-founders and the relatively low-capital type of work it does. Yet an explanation is warranted here: Kakute and Dorto did not have more financial resources than the other SEs. In reality, these two seemed to be the ones with the least

financial resources. Nonetheless, they were surviving autonomously, without external core funding or capital contributions. Kakute has seen better days, financially speaking, but it is a veteran SE that has been operating since 1995. Compared to the other case SEs, Kakute is by far the oldest one and has no direct ties to any foreign donors or investors. Kakute's resources consist of a relatively spacious headquarters in which they hosted at least two partners (other SEs who also were incubatees of Kakute) for reasonable rent, project contracts, and the contributions of the company's guarantors (or co-owners) who are not many or wealthy. For these reasons, despite their busy profile and visible impact as technology diffusors, Kakute itself is not thriving economically. Dorgo, on the other hand, is significantly younger (about 2 years old) and smaller in capital and staff, but it is also surviving by returns from its own products and services. Yet these two SEs do not think that they no longer need external financing. In interviews and conversations with their managements (particularly FS01 and GS01) they still contemplated possibilities of receiving investment or funding that could allow them to significantly improve their current business status.

On the other hand, it was expressed a number of times by the GCS staff that technically their company is currently at the break-even scale (AS01, AS03 and AS10 interview), which means, according to them, that GCS is technically capable of maintaining its own operations through its own generated revenues from sales. However, GCS has effectively been engaged in long-term financial support schemes from business-support programs by larger development donors and investors who took interest in its last mile distribution model (to which the microfranchizing rafiki network belongs) (XX02 interview).

Another situation is found with the BCEs. BCEs were initiated by TDBP, but they are essentially independent enterprises. Up to the time of the field study, many BCEs received

financial and technical support from TDBP, but they varied in terms of their commercial success, as explained earlier. Some co-founders of BCEs that were interviewed were quite aggressive marketers and shrewd businesspersons dedicated to their ventures. Eventually a number of them reaped the fruit of their persistence.

Overall, long-term financial viability seemed to be a challenge that all the case SEs grappled with. None of them had a definitive solution to that challenge, but each one is working towards it.

Social Enterprise Clusters

In Arusha, Tanzania, there is what may be described as an experimental social enterprise cluster, in a location called TASO grounds (belonging to the Tanzania Agricultural Support Organization). A group of SEs in that location work with each other in multiple ways. For example, Kakute – the oldest SE on the grounds – incubated a start-up SE which came in from Germany with investments to provide affordable solar PV systems for average households in rural and urban Tanzania. By the end of the incubation period (about 2 years), Mobisol became a brand name in the region. Currently both SEs still share some office space and work as partners although they are autonomous. Additionally, in 2013, two organizations, GCS and another SE, shared market intelligence for mobile solar PV lanterns in the Tanzania Northern Zone, and also shared some logistical expenses (such as sharing a 4x4 rental car for field operations for a few months). Moreover, GCS and Twende decided that it would be cost-effective to build office space together on an available small piece of land at the TASO grounds. In the shared building they also share a machine shop, internet subscription, office appliances, and sometimes vehicles. They also shared contacts, information and efforts about innovating particular agricultural machines for the local market. Their staff casually lend a hand to each other on need basis. AISE

was more or less born from the cooperation of the GCS and Twende (before the merger of AISE-Twende), then started to have its own flavour as an innovation lab and educational centre for school students who like to learn more about appropriate technologies and their creation. AISE was part of the vision and work of a Tanzanian technology innovator (SC01 interviewee) who has been active in both GCS and Twende. In 2014 AISE merged with Twende to form AISE-Twende (now simply called Twende). Additionally, as detailed earlier, the software project that was launched to keep the rafiki network connected eventually gave birth to another SE, RafikiSoft, which provides customized ICT products and services to companies with rural distribution networks. RafikiSoft then continued to have strong ties with GCS – being its first and largest customer to date – while seeking new clientele. Due to proximity and related expertise, each of the boards of directors of GCS, Twende and Kakute have members from the leadership of at least one neighboring organization. Overall, collaborative efforts are continuing between these SEs as they are located in close proximity to each other. The leading staff of all these organizations know each other well and have relatively easy access to each other as needed.

What we see in Arusha's TASO grounds could be described as a small SE cluster. If a network of SEs can be established and they can work in collaboration with each other, there seems to be an opportunity for mutual benefits and for enhancing the SE sector in the region.

CHALLENGES AND OPPORTUNITES OF LOCALIZATION

Besides the responses to the research questions there appeared to be challenges and opportunities observed during the field study about the work of social enterprises in technology localization in Tanzania.

Challenges

The problem of seasonality:

The majority of the SEs' staff who participated in this field study mentioned the challenge of seasonality as a recurrent and persisting challenge for them. Staff of GCS, BCEs, Dorgo and Kakute highlighted this challenge in their interviews. Moreover, a significant number of the technology adopters interviewed – from rural communities – spoke about seasonality in similar ways (interviewees AU06, AU15, TSU06 and TSU07). The rural entrepreneurs interviewed – *rafikis* with GCS and masons of the BCEs – appeared to be the most affected by seasonality, since they more than others depend on the purchasing power in their communities.

The problem we can call seasonality is not difficult to observe in rural Tanzanian communities, and affects the possibilities for technology adoption in rural communities. Since the main rural economic activity in Tanzania is agriculture, it is not a surprise that rural economic vitality depends heavily on a good agricultural economy (i.e. production and sales). The quality and quantity of the crops being cultivated, the level of demand for them in the market, and their pricing, all affect the entire economy of rural-agricultural communities. Crops however are primarily seasonal. They only start to generate revenue for agricultural producers after harvest. Before the harvest of high-demand crops the rural-agricultural community is cash-poor. When the community members have little cash to spend, their purchasing activities are restricted to essentials. Spending is restrained on products and services that may improve quality of living but which are not immediately necessary. Therefore, businesses that provide such products and services can only perform well in rural markets during harvest seasons and a little afterwards when rural households have some surplus cash. But rural businesses like that tend to be often small, with small capital, and therefore quite vulnerable to seasonality, because they are

expected to operate year-long but only make good revenue in a window of about 3 to 5 months a year. It becomes a challenge of survival for small rural businesses, and similarly for emerging rural-oriented social enterprises. Bigger businesses - such as established companies and transnational corporations - can sometimes handle seasonality because they are stronger and more resilient in the face of market fluctuations, and they can plan for seasons more capably. But seasonality can be fatal for small businesses and young SEs. This problem is amplified when some harvest seasons do not deliver the expected yield of crops, or they do but the market does not perform as vibrantly as expected that year for one reason or another. Small businesses may not be able to survive a year like that.

This problem has no immediate local solutions in the present time, but it surely has a domino effect. Because seasonality is a consistent problem for rural Tanzania, fewer people are interested in establishing businesses that can provide various products and services in rural communities. Between those who fail in running their rural-based businesses and those who decide against taking the risk of establishing ones, the main losers often happen to be the rural communities overall.

While sustainable energy technologies such as solar lanterns, biogas energy and energy-efficient cookstoves, are important things to have for rural households, they can be deemed non-essential in times of shortage of cash. The same applies to agricultural equipment that can improve productivity and convenience but requires initial investment in cash. Seasonality is thus a challenge for all businesses involved in marketing these technologies to rural communities, including SEs for whom a break-even operation is necessary.

Infrastructure:

A common challenge for all actors in technological change is the country's infrastructure. SE staff complained, in their interviews, that the status of the network of roads in the country makes it a difficult and costly process to reach rural communities in various regions of Tanzania, whether to promote products and services or to distribute them. For example, GCS management claims to spend a fortune to keep a few SUV vehicles on the road as field officers use them to go nationwide promoting and distributing GCS merchandize (AS10, AS01, AS20). The cost of continuous maintenance and fixing of these vehicles can be high due to the types of unpaved and unfriendly roads they continuously take on their missions.

Yet, as some SE staff also pointed out (such as AS01 and AS03), if the infrastructure improves, that will render many of the current activities and approaches of SEs to technology diffusion in rural areas obsolete. If the roads get better then probably GCS' last-mile distribution model will not be as important as it is now for many rural communities, because they can then reach markets in towns and cities more easily. Also, infrastructure improvement usually comes in packages, so more roads will probably also accompany an extension of the national electric grid. That would be good news for the rural communities but will make them less interested in the solar lanterns and home systems marketed by SEs. Ultimately many of these SEs provide solutions to problems that would not have existed if the status of the national infrastructure was better than it currently is. As the infrastructure improves, eventually, it will require SEs to reinvent themselves to address other development issues, in both their models of diffusion and the technologies they localize.

Opportunities

Identified local partners:

There are a number of Tanzanian parastatal organizations whose main mandate is to provoke and foster innovation in technology and engineering. They are also called Public Technology Intermediaries (PTIs). Most of them were established in the seventies and early eighties and have a record of innovative projects of technology and engineering solutions in their fields (Diyamett & Risha 2015). They foster innovation through technical assistance, design and incubation for innovative technology ideas. Some of those ideas come from their staff engineers and technicians; others come from the communities, and others come from local innovators and entrepreneurs. According to interviews conducted with some representatives of these PTIs (Interviews SP01, KP05 and KP01), few SEs collaborate wisely with these PTIs as partners in some technological projects. GCS and Kakute have collaborations with the Centre for Agricultural Mechanization and Rural Technology (CAMARTEC) and with the Small Industries Development Organization (SIDO). TDBP is hosted by CAMARTEC. There are good opportunities for more and enhanced collaborations of this sort if the policy environment facilitates the realization of that potential.

Flexibility of the social enterprise business model:

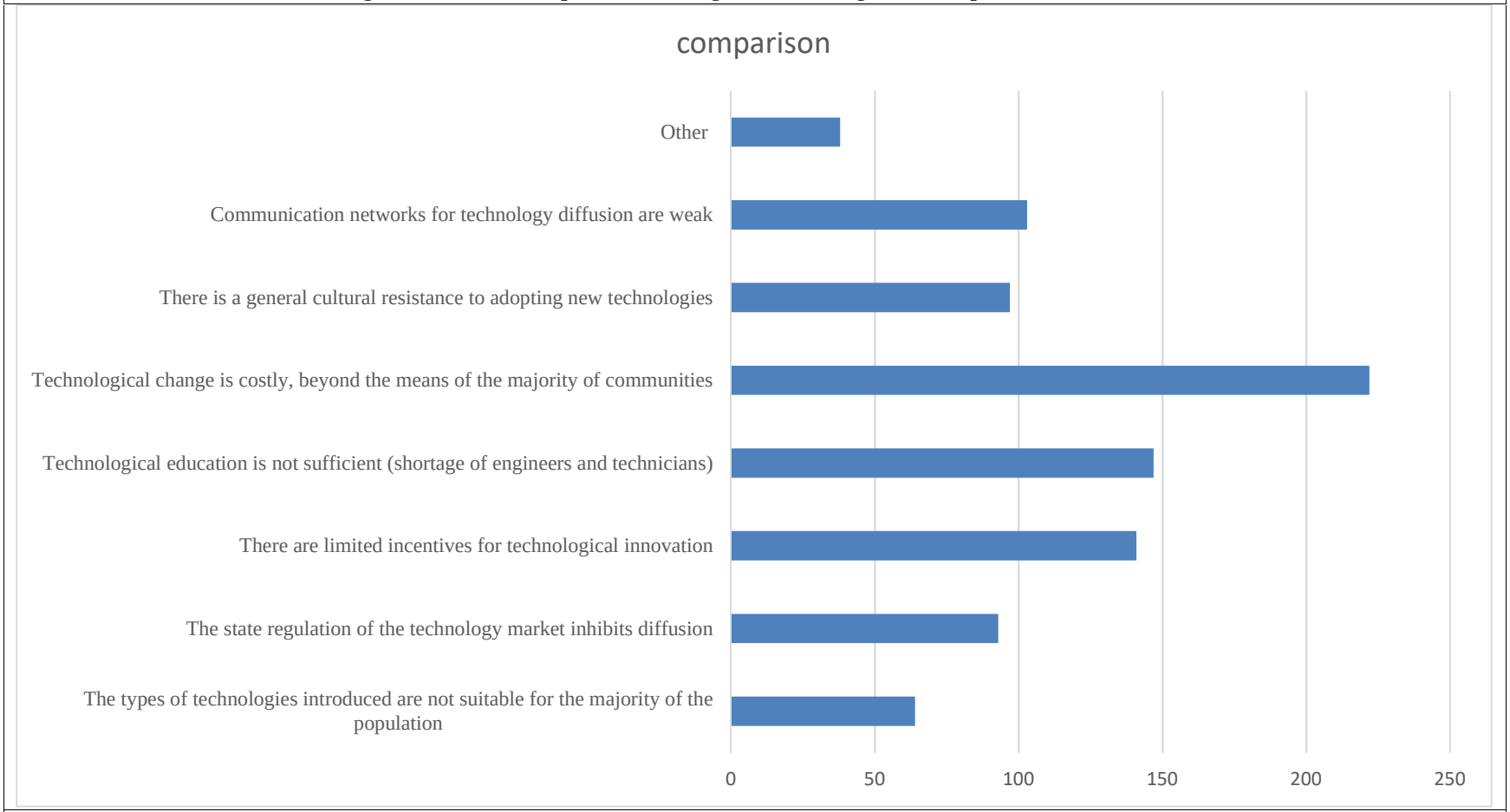
The identity of some SEs, such as the case SEs of this field study, seem to be flexible. Kakute was registered as a private business, and it had two spin-offs in the past that were direct private businesses (FS01 interview). GCS has been identifying as a social enterprise since inception but is aspiring “to get rid of the “social” eventually and become just ‘an enterprise’” with more rigorous business structure and operations (AS10 interview). The TDBP’s aim is to eventually make biogas a viable commercial sector and for BCEs to become viable free-standing businesses

in the Tanzanian market (not necessarily as cooperatives of certified masons). Dorgo as well may become a conventional private firm that produces agro-machineries in the future, and that may make it more effective in production, distribution and responding to the demand of rural communities (i.e. through mass-production and sale which lowers prices of products and assures standardization of quality in addition to product warranties). The flexibility of SEs in changing their status may be an advantage of the social enterprise approach—that it can transform from one organizational identity to another, under appropriate circumstances, if that serves its goals, and technology localization, more.

PARTICIPANTS' PERSPECTIVES ON THE NATIONAL CHALLENGES

The interviews of the field study also sought to learn the opinion of all interviewees about what they perceive as the most eminent challenges to technological change in Tanzania. The question sought to survey perspectives of the research participants about the national context within which they are active. The interviews were an opportunity to gather such opinion-based data that may be helpful in understanding how the perception of the general national context relates to the priorities of technology diffusion by SEs. Figure 2 shows the results of the answers to that question—statements with the larger scores were perceived the bigger challenges in terms of importance.

Figure 2 Interview responses: challenges to technological development in Tanzania*



***The question was: Mark the major challenges to technological development in this country/region (prompt: rank the top 4 challenges in your opinion)

CHAPTER VI: CONCLUDING REMARKS

This manuscript began with a proposed framework for technological autonomy that pointed to the importance of technology localization and identified the role of agents of technological change in the pursuit of localization. The field study narrowed the focus to social enterprises in the process of technology localization by studying the role of social enterprises as agents of localization in rural Tanzania. The results suggest that social enterprises have a credible potential as agents of technological change in Tanzania, through their work in technology localization. This makes social enterprises valuable assets in technological development in Tanzania, leading to eventual technological autonomy as anticipated in the Tanzanian National Development Plan II (FYDP-II). This claim of the potential of social enterprises can be reasonably extended to other East African countries.

The renowned biochemist and philosopher, Lawrence Joseph Henderson, was attributed with saying, “Science owes more to the steam engine than the steam engine owes to science.” The statement suggests that technological breakthroughs often usher in scientific breakthroughs. This is not always the case, of course, but has been a consistent trend in most of human history. The industrial revolution is a prime example of this. The engineering work of the steam engine ushered in new attempts to understanding heat transfer and thermal energy, leading to discovering the laws of thermodynamics. While highly debatable in today’s intricate integration of massive, cutting-edge technology and scientific frontiers, this observation nonetheless bears relevance to the context of developing societies. There is wisdom in focusing on increasing a country’s technological capabilities and processes of technology localization. Prioritizing technological development can unleash the endogenous creative forces that could innovate and implement solutions to local economic, social and environmental problems. It can also launch

developing societies on learning curves that make them gradually attain and internalize advanced scientific knowledge and creative capacities (STIPRO 2010).

The pursuit of technological autonomy through the activities of technology localization are connected to human and economic development aspirations of the populations of developing societies. This research has shown that social enterprises can play a positive role as agents of technological change. As a result, development practitioners and scholars should pay them more interest.

As discussed earlier, there are good reasons to conditionally extend the conclusions of this study from Tanzania to East Africa. There are also similar reasons to think about whether those conclusions can encourage similar lines of work and research in developing countries more generally. Earlier reviews of the status of social enterprises in various developing countries around the world tell us diverse stories that may not be easily generalized. There are however, similar trends of new approaches to solving old problems. There are also examples of social enterprises already engaging in activities of technological development. We can conclude from such reviews, and this study, that there are no strong reasons to dismiss the possibility that the conclusion of this study may be have broader implications than Tanzania and East Africa.

IMPLICATIONS OF THE STUDY

This research provides intellectual support for efforts to enhance the enabling environment for emerging agents of technological change in Tanzania. As Tanzania is witnessing policy shifts regarding the involvement of local non-state actors (e.g., private sector and third sector) in economic development and diffusion of innovations, this research can draw attention to the value of regulations that accommodate social enterprise and formally acknowledged models of business. For example, since social enterprises represent an array of organizations that are

neither simply for-profit nor charitable status, business registration and taxation schemes by the state could accommodate them with business type registration options that do not currently exist. Additionally, regional governments could consider involving SEs for inclusion in government-led localization projects, whether in diffusion, institutional support (e.g., managing finance and credit systems, or providing technical training assistance to communities) or technical adaptation. As governments are known to sometimes relegate parts of their big projects to NGOs or CBOs to fulfill parts of the projects for particular communities, they can include SEs as well.

The research also helps in clarifying some of the demands and expectations of communities of potential adopters of new technologies in developing rural communities. The feedback of the clients of the case SEs brings to light some of their perceptions about the effectiveness of the technological products and services they adopted that should receive more attention in future efforts of technology localization (whether by the case SEs or other agents of localization). Also, generally, this research contributes to the growing scholarship of social enterprise in developing societies. As discussed earlier, the literature is currently centred on social enterprise and entrepreneurship in the economic North, but some shifts are taking place.

Finally, the technology localization concept, constructed through this thesis, can be used further to aid in developing new or modified explanations for technological change processes in developing societies. It can also contribute to guiding related research on technology localization and agents, identifying research gaps in topics of technological change, and contributing to policy formation for more coherent approaches to localization. It could also incite some researchers to explore what others activities besides diffusion, institutional support and technical adaptation could be included under the localization umbrella.

LIMITATIONS OF THE STUDY

The data collection could have been stronger. For example, the size and diversity of the SEs included and the number of persons interviewed from each SE could be increased. In addition the number of interviews with community members could always have been increased. The number of communities observed could have been increased as well.

This study is also limited by its narrowed focus on the activities of social enterprises. Other factors that have immense influence on the development process in rural Tanzania and Tanzania in general have not been integrated into the analysis. For example, the sociological, environmental and legal intricacies that smallholder farmers in Tanzania grapple with are not addressed, and thus the sources of their resistance to technological change – and how to overcome that resistance – are not included in this research. It is quite conceivable that politics and legalities of land tenure, crop prices, and environmental challenges to agricultural produce (e.g. droughts) will significantly limit the potential for technology localization among many rural communities in the country.

Additionally, this study took place in a limited time period. It can be reasonably expected that some of the cases would face more fluctuations in their experiences over longer spans of time. Some of the cases were also relatively young, thus it cannot be said that their stories satisfy reasonable conditions of durability. Moreover, being a relatively new concept – yet synthesized from older concepts – the concept of technology localization itself may require further elaboration through the identification of additional localization activities and more robust measures and indicators of all localization activities.

SUBJECTS FOR FUTURE RESEARCH

The case of TDBP, and the partnerships between some of the cases and Tanzania's public technology intermediaries, show that social enterprises could work well in partnership with the public sector in developing countries. Research that explores such partnerships would benefit decision makers, practitioners and the social enterprise research community. The findings of this study may be conditionally generalized about rural East Africa, since rural conditions in the region are often comparable across national borders. Ultimately however it would depend on the national policy and attitude towards the private sector. Tanzania is visibly different from the other East African countries in this aspect, due to its legacy of a long-lasting command economy which was less friendly towards the private sector than neighbouring Kenya, for example. That is changing however, as discussed earlier (chapter III). Differences in national enabling environments (policies, infrastructure, etc.) may pose a limitation to generalizing the results of this study to other East African countries. Future research could take comparisons of national policies and how social enterprises perform under them.

Another possible topic for future research can be on models of diffusion, discussed in chapter V. They rely on different elements that make each model successful or problematic. Also, models can be replicated (with modifications). Studying models of diffusion, such as microfranchizing, sector-enterprise cultivation, and business-technology incubation, is a good suggestion for future research as it will make the lessons learned from this research more useful for a wider range of researchers and practitioners.

Another area of possible future research can be about how social enterprises integrate environmental principles, and climate change awareness, in their technology localization efforts. As climate change is no longer a topic that can be postponed in many developing countries,

approaches to technological autonomy will need to include it. Can social enterprises help communities in activities of technology localization that are conducive to low-carbon industrialized economies?

Finally, the field study provides supportive evidence that empowering rural women works well with, and for, technology localization. The researcher interviewed multiple rural women among the clients of social enterprises – around half of the interviewed clients were women – and interacted with others in the field. There was a visible level of enthusiasm for new technology adoption among the women that were interviewed and observed. Many of them engaged new technologies with eagerness to learn and to seize whatever opportunities they could bring to improve their livelihoods and those of their families. Multiple women *rafikis* proved to be tenacious entrepreneurs and early adopters. In a trend that is visibly more than simply isolated cases, the results of economic improvement in these women' households was directly felt in the quality of life and the education of the children of the household. Women *rafikis* appeared to invest immediately in their family members: better food and water supply, sanitation, better housing conditions and better schools (for their children). This gendered aspect is worth further investigation in future research. It would be appropriate to have a research project devoted exclusively to the role of women in the work of social enterprises, or relevant research that more systematically disaggregates data by sex.

REFERENCES

Abukasawi, Mustafa J. and Elkarib, Asha K. 2004. *Evaluation of Women Development Associations [WDAs] Project*. Khartoum: Intermediate Technology Development Group [ITDG].

Adeel, Zafar, Schuster, Brigitte and Bigas, Harriet (eds.). 2008. *What Makes Traditional Technologies Tick? A review of traditional approaches for water management in drylands.* United Nations University, UNU-INWEH.

Adesina, Akinwumi A. and Baido-Forson, Jojo. 1995. "Farmers' perceptions and adoption of new agricultural technology: evidence from analysis in Burkina Faso and Guinea, West Africa." *Agricultural Economics,* 13: 1-9.

Adrian Innovation Center. 2015. "Frequently Asked Questions." Viewed on October 13, 2015 at: http://adrianinnovation.squarespace.com/blog/2015/9/4/business-incubation-faqs

AISE (Accelerating Innovation and and Social Entrepreneurship) website. Accessed July 2014. http://aisetanzania.tumblr.com/

Altenburg, Tilman. 2008. "Building inclusive innovation systems in developing countries – why it is necessary to rethink the policy agenda." Paper presented in the IV Globelics Conference, Mexico City, September 22-24.

Alter, Kim. 2007. *Social Enterprise Typology.* Report of Virtue Ventures LLC. Updated November 27.

Alvord, S.H., Brown, L.D., and Letts, C.W. 2004. "Social entrepreneurship and societal transformation: an exploratory study." *The Journal of Applied Behavioral Science*, 40(3): pp. 260–282.

Amm, Kathryn. 2009. *Social Enterprises, Social Value and Job Creation in Cape Town.*Master's thesis, Nelson Mandela Metropolitan University.http://www.nmmu.ac.za/documents/theses/AMM%20dissertation%20march%202010.pdf (accessed August 11, 2012)

Anderson, R., Dana, L., and Dana, T. 2006. "Indigenous land rights, entrepreneurship, and economic development in Canada: 'opting-in' to the global economy." *Journal of World Business*, 41(1): pp. 45–55.

Al-Ghafri, Abdullah S. 2008. "Traditional Water Distribution in Aflaj Irrigation Systems: Case Study of Oman" in Zafar Adeel, Brigitte Schuster and Harriet Bigas' (eds.) *What makes traditional technology tick? A review of traditional approaches for water management in drylands.* Hamilton, Ontario: The United Nations University (UNU-INWEH). Chapter 8: 74-85.

Arthur, W. Brian. 1989. "Competing Technologies, Increasing Returns, and Lock-in by historical events." *The Economic Journal*, 99(394): 116-131.

Ash, Robert, Joseph Linn and C. J. Wu. 2006. "The Economic Legacy of the KMT" in Dafydd Fell, Henning Klöter & Bi-yu Chang's (eds.) *What has Changed? Taiwan Before and*

After the Change in Ruling Parties. Harraswitz Verlag. Wiesbaden. Chapter 5, pp. 83 – 106.

Aubert, Jean-Eric. 2005. "Promoting Innovation in Developing Countries: A Conceptual Framework." Policy Research Working Paper; No. 3554. World Bank, Washington, DC.

Aunger, Robert. 2010. "Types of Technology." *Technological Forecasting & Social Change*, 77: 762-82

Barry, Boubakar, A. O. Olaleye, R. Zougmore and D. Fatondji. 2008. "Rainwater Harvesting Technologies in the Sahelian Zone of West Africa and the Potential for Outscaling." Working paper 126, International Water Management Institute.

Bennett, A. 2004. "Case study: Methods and analysis." In N. J. Smelser & P. B. Baltes (Eds.), *International Encyclopedia of the Social & Behavioral Sciences* (pp. 1513-1519). Elsevier

Binswanger, Hans. 1986. "Agricultural Mechanization: A comparative historical perspective." *World Bank Research Observer*, 1(1): 27-56.

Borgmann, Albert. 2010. "Reality and Technology." *Cambridge Journal of Economics,* 34: 27-35.

Brint, Steven, Proctor, Kristopher, Hanneman, Robert A., Mulligan, Kerry, Rotondi, Matthew B. and Murphy, Scott P. 2011. "Who are the early adopters of new academic fields? Comparing four perspectives on the institutionalization of degree granting programs in US four-year colleges and Universities, 1970–2005." Higher Education, 61(5): pp 563-585.

Buell, Becky and Mayne, Ruth. 2011. "Bringing social equity into low-carbon investment: why it matters and emerging lessons." Retrieved September 27, 2013 from: http://web.mit.edu/colab/pdf/papers/Carbon_Equity_Full_Paper.pdf

Commission for Science & Technology (COSTECH), Tanzania. nd. "Directorate, Centre for Development and Transfer of Technology." Accessed August 15, 2013. http://www.costech.or.tz/?page_id=1657

Coulson, Andrew. 1982. *Tanzania: a political economy* (2nd ed). Oxford: Oxford University Press.

Daberkow, Stan G. and McBride, William D. 1998. "Socioeconomic Profiles of Early Adopters of Precision Agriculture Technologies." *Journal of Agribusiness*, 16(2): 151-168.

Dacanay, Marie Lisa M. 2012. *Social enterprises and the poor: Enhancing social entrepreneurship and stakeholder theory.* Dissertation: Doctoral school of organization and management studies, Copenhagen Business School, Denmark.

Dalton, George. 1990. "Writings that clarify theoretical disputes over Karl Polanyi's work" in Kari Polanyi-Levitt's (ed.) *The life and work of Karl Polanyi.* Montreal: Black Rose Books. Chapter 18: 161-170.

Dart, Raymond. 2004. "The legitimacy of social enterprise." *Nonprofit Management & Leadership*, 14(4): 411-424

Dees, J. Gregory. 2007. Taking social entrepreneurship seriously. Society 44(3): pp. 24– 31.

Defourny, J. and Nyssens, M. 2008. "Social enterprise in Europe: recent trends and developments." *Social Enterprise Journal.* Vol 4 No 3. pp. 202-228.

Dengu, Ebbie, El-Garrai, Omer and Abdalla, Asim H. 2006 (May). *Evaluation of The Food Security Project: Re-Establishing Food Self-Reliance Amongst Drought Affected People of North Darfur*. Khartoum: Practical Action Sudan.

Dercon, Stefan and Christiaensen, Luc. 2011. "Consumption risk, technology adoption and poverty traps: Evidence from Ethiopia." *Journal of Development Economics,* 96: 159-173.

Desta, A. 2010. "Microcredit for poverty alleviation and fostering environmentally sustainable development: a review of African case studies." *International Journal of Business Research*, 10(2): 1-26.

Department of Trade and Industry, Great Britain. 2002. *Social Enterprise: a strategy for success.*

Desai, Meghnad, Fukuda-Parr, Sakiko, Hohansson, Claes and Sagasti, Fransisco. 2002. "Measuring the Technology Achievement of Nations and the Capacity to Participate in the Network Age." *Journal of Human Development,* 3(1): 95-122.

Di Domenico, MariaLaura, Helen Haugh, and Paul Tracey. 2010. "Social Bricolage: Theorizing social value creation in social enterprises." *Entrepreneurship Theory and Practice,* July issue.

Diyamett, Bitrina and Risha, Neema. 2015. "Tanzania Manufacturing Systems of Innovation (TMSI): A report on the mapping of the public technology intermediaries." Report by the Science, Technology and Innovation Policy Research Organization (STIPRO), August 2015.

Dosi, Giovanni. 1982. "Technological paradigms and technological trajectories: A suggested interpretation of the determinants and directions of technological change." *Research Policy*, 11 (1982): 147-162.

Dutta, Soumitra and Lanvin, Bruno (eds.). 2013. Global Development Index Report: The Local Dynamics of Innovation. Geneva: World Intellectual Property Organization (WIPO), and New Delhi: Confederation of Indian Industry (CII).

Eisler, Riane. 2002. "The Dynamics of Cultural and Technological Evolution: Domination versus Partnership." *World Futures,* 58(2&3): 159-174.

Encyclopedia Britannica (website). Search word: Technology. Accessed July 30, 2013. http://www.britannica.com/EBchecked/topic/585418/technology

Entrepreneur's Toolkit for Social and Environmental Entrepreneurs. 2007. "Case Study: The Ethical Co-op." Accessed August 11, 2012. http://www.entrepreneurstoolkit.org/index.php?title=Case_Story%3A_The_Ethical_Co-op

Fidiel, Mohammed M. 2001. "The experience of the Intermediate Technology Development Group in participatory development of the donkey-drawn plough in North Darfur, Western Sudan." ITDG Publications, Advancing PTD: ITDG Sudan case study.

…….. 2005. *Building Small Scale Water Harvesting Dams: The experience of intermediate technology development group, North Darfur State - Western Sudan.* Retrieved Sep 10, 2009 from: http://practicalaction.org/sudan/docs/region_sudan/water-harvesting.pdf

Flyvbjerg, Bent. 2006. "Five Misunderstandings About Case-Study Research", *Qualitative Inquiry*, 12(2): 219-245.

…… 2011. "Case Study", in Norman K. Denzin and Yvonna S. Lincoln, eds., *The Sage Handbook of Qualitative Research*, 4th Edition. Thousand Oaks, CA: Sage, pp. 301-316.

Franklin, Ursula. 1989. *The Real World of Technology.* CBC Massey lectures, Tuesday, November 7th. Retrieved on August 25, 2013 from CBC Massey Lectures Archives: http://www.cbc.ca/ideas/massey-archives/1989/11/07/1989-massey-lectures-the-real-world-of-technology/

Franssen, Maarten, Lokhorst, Gert-Jon and de Poel, Ibo van. 2013. "Philosophy of Technology." *The Stanford Encyclopedia of Philosophy (Fall 2015 Edition),* Edward N. Zalta (ed.), URL = <http://plato.stanford.edu/archives/fall2015/entries/technology/>.

Galtung, Johan. 1979. *Development, Environment and Technology: towards a technology for self-reliance.* New York: United Nations.

Gamser, Matthews S. 1988. "Innovation, Technical Assistance and Development: The Importance of Technology Users." *World Development,* 16(6): 711-721.

GCS Tanzania Ltd. website. Accessed July 2014. http://www.gcstz.com/

Gilbert, Jess. 2009. "Democratizing states and the use of history." *Rural Sociology,* 74(1): 3-24.

Goodwin, Jeff and Ruth Horowitz. 2002. "Symposium on Methodology in Qualitative Sociology. Introduction: The Methodological Strengths and Dilemmas of Qualitative Sociology." *Qualitative Sociology,* 25: 33-47.

Granados, Maria L., Hlupic, Vlatka, Coakes, Elayne and Mohamed, Souad. 2011. "Social enterprise and social entrepreneurship research and theory: A bibliometric analysis from 1991 to 2010." *Social Enterprise Journal,* 7(3): 198-218.

Gulrajani, Mohini. 2006. "Technological Capabilities in Industrial Clusters: A case study of textile cluster in Northen India." *Science, Technology & Society,* 11(1): 149-90.

Haider, Muhiuddin, and Kreps, Gary L. 2010. "Forty Years of Diffusion of Innovations: Utility and Value in Public Health." *Journal of Health Communication,* Vol. 9(1): 3-11.

Harriss, John. 2003. "Institutions, Politics and Culture: a Polanyian Perspective on Economic Change." *International Review of Sociology,* 13(2): 343-355.

…….. 2002. "The case for cross-disciplinary approaches in international development." *World Development,* 30(3), 487-496.

Haug, David M. 1992. "The international transfer of technology: Lessons that East Europe can learn from the failed third world experience." *Harvard Journal of Law & Technology,* 5 (Spring Issue): 209-240

Haugh, Helen. 2012. "The importance of theory in social enterprise research." *Social Enterprise Journal,* 8(1): 7-15.

Henderson, Paul and Vereseg, Ilona. 2010.*Community Development and civil society: Making connections in the European context.* The Policy Press.

Hesse-Biber, Nagy, Sharlene and Leavy, Patricia. 2004. Approaches to Qualitative Research: A Reader on Theory and Practice. NY: Oxford UP.

Hill, Ronald Paul & Kanwalroop Kathy Dhanda. 2003. "Technological Achievement and Human Development: A View from the United Nations Development Program." *Human Rights Quarterly*, 25(4): 1020-1034

Hodgson, Geoffrey. 2007. "The enforcement of contracts and property rights: Constitutive versus epiphenomenal conceptions of law" in Mark Harvey, Sally Randles and Ronnie Ramolgan's (eds.) *Karl Polanyi: New perspectives on the place of the economy in society.* Manchester: Manchester University Press. Chapter 4: 58-77.

…….. 2004. "Institutional Economic Thought " *International Encyclopedia of the Social & Behavioral Sciences,* Pages 7543-7550. Amsterdam: Elsevier.

Hopkins, Terence K. 1957. "Sociology and the Substantive View of the Economy" in Karl Polanyi, Conrad M. Arensberg and Harry W. Pearson's (eds.) *Trade and market in early empires: Economies in history and theory.* Glencoe, IL: The Free Press. Chapter 14: 270-307.

Howes, Michael and Chambers, Robert. 1979. "Indigenous technical knowledge: Analysis, Implications and Issues." *Institute of Development Studies (IDS) Bulletin*, 10.2

Huh, Y.E. and Kim, S.H. 2008. "Do early adopters upgrade early? Role of post-adoption behavior in the purchase of next-generation products." Journal of Business Research, 61(1): 40-46.

Hyden, Goran. 1980. *Beyond Ujamaa in Tanzania: Underdevelopment and an uncaptured peasantry.* Berkeley and Los Angeles, CA: University of California Press.

……. . 2006. "Introduction and Overview to the Special Issue on Africa's Moral and Affective Economy." *African Studies Quarterly*, 9(1 & 2).

Hyman, Eric L. 1987. "The Identification of Appropriate Technologies for Rural Development." *Impact Assessment*, 4(5): 35-55.

Jackson, Tom. 2015. "RafikiSoft helping NGOs, social enterprises address unique challenges". *Distrupt Africa*. April 27. Retrieved from: http://disrupt-africa.com/2015/04/rafikisoft-helping-ngos-social-enterprises-address-unique-challenges/

Japan Automobile Manufacturers Association (JAMA). nd. "Towards Industrialization (1935-1945)". Retrieved on August 20, 2013 from: http://njkk.com/about/industry2.htm

Jennings, Michael. 2008. *Surrogated of the State: NGOs, development, and Ujamaa in Tanzania.*Bloomfield, CT: Kumarian Press, Inc.

Jensen, J. L., and Rodgers, R. 2001 (March/April). "Cumulating the intellectual gold of case study research." *Public Administration Review*, 61(2), 235-246.

Jiao, Hao. 2011. "A conceptual model for social entrepreneurship directed toward social impact on society." *Social Enterprise Journal*, 7(2): 130-149.

Jones, Monty. 2009. “Key Challenges for Technology Development and Agricultural Research in Africa.” *IDS Bulletin (*Institute for Development Studies), Vol. 34(2): 46-51. http://onlinelibrary.wiley.com/doi/10.1111/j.1759-5436.2005.tb00195.x/abstract (accessed August 7, 2012).

Kakute Ltd. 2007. “International Training Workshop on Awareness and Promotion of Jatropha Curcus for Bioenergy Related Technology and Improve Livelihood.” Workshop manual, Arusha, Tanzania.

Kandji, Serigne Tacko, Verchot, Louis and Mackensen, Jens. 2006. “Climate Change and Variability in the Sahel Region: Impacts and Adaptation Strategies in the Agricultural Sector.” Report by World Agroforestry Centre (ICRAF) and the United Nations Environment Programme (UNEP).

Karanda, Crispen and Toledano, Nuria. 2012. "Social entrepreneurship in South Africa: a different narrative for a different context". Social Enterprise Journal, 8(3): 201-215

Kim, Linsu and Nelson, Richard R. (eds.). 2000. *Technology, Learning and Innovation: Experiences of Newly Industrializing Economies.* New York: Cambridge University Press.

Kroszner, Randall. 1987. “Technology and Control of Labour” a review of *Forces of Production: a Social History of Industrial Automation* by David F. Noble. *Critical Review*, 1(2): 6-16.

Lall, Sanjaya. 1992. “Technological capabilities and industrialization.” *World Development,* 20(2): 165-186.

Lautermann, Christian. 2013. “The ambiguities of (social) value creation: towards an extended understanding of entrepreneurial value creation for society.” *Social Enterprise Journal*, 9(2): 184-202.

Laratta, Losario, Nakagawa, Sachiko and Sakurai, Masanari. 2011. "Japanese social enterprises: Major contemporary issues and key challenges." *Social Enterprise Journal*, 7(1): 50-68.

Lehr, David. 2008. “Microfranchising at the Base of the Pyramid.” Acument Fund: Working Paper. August 2008. Accessed October 13, 2016. https://web.archive.org/web/20120617053148/http://www.acumenfund.org/uploads/assets/documents/Microfranchising_Working%20Paper_XoYB6sZ5.pdf

Lekoko, Rebecca N. and Semali, Ladislaus. 2012. *Cases on developing countries and ICT integration: Rural community development.* IGI Global.

Lim, A. K., Yap, N. and Devlin, J. 2015. “Democracy and Enterprise: A Philippine Cooperative Balances Social and Business Demands.” *International Journal of Community Development*, 3(2): 51-63.

Lucena, Juan, Schneider, Jen and Leydens, Jon A. 2010. *Engineering and sustainable community development.* Morgan & Claypool Publishers.

Lundvall, Bengt-Åke (ed.). 1992. *National Innovation Systems: Towards a Theory of Innovation and Interactive Learning*. London: Pinter.

Maharajh, Rasigan, Scerri, Mrio and Sibanda, Mclean. 2013(March). *A review of the National Innovation System of the United Republic of Tanzania: External Review Report.*

Mair, Johanna, and Schoen, Oliver. 2007. "Successful social entrepreneurial business models in the context of developing economies." *International Journal of Emerging Markets.* Vol 2(1): 54-68.

Mair, J., and Marti I. 2006. "Social entrepreneurship research: a source of explanation, prediction, and delight." *Journal of World Business,* 41(1): pp. 36–44.

Martinez-Torres, Elana, Maria, Rosset, Peter M. 2010. "La Via Campesina: the birth and evolution of transnational social movement." *Journal of Peasant Studies,* 37(1): 149-175.

Marx, Karl. 1977. A Contribution to the Critique of Political Economy. Moscow: Progress Publishers. (original manuscript published 1859)

…….. 1887. Capital, Volume I. Moscow: Progress Publishers. (original manuscript published 1867)

Mazrui, Ali Al'Amin. 1986. "Tools of Exploitation." Part 4 of *The Africans: A Triple Heritage,* a BBC documentary series.

Mazzucato, Mariana. 2013. *The Entrepreneurial State: Debunking public vs. private sector myths*. New York: Anthem Press.

Menard C. and Shirley, M. M. (eds.). 2005. *Handbook of New Institutional Economics.* The Netherlands: Springer.

Ministry of Energy and Minerals, United Republic of Tanzania. The Draft National Energy Policy. January 2015, Dar es Salaam.

Ministry of Finance and Planning, Tanzania. 2016. National Five-Year Development Plan 2016/17 – 2020/21: Nurturing Industrialization for Economic Transformation and Human Development. June 2016.

Ministry of Trade and Industry, Tanzania. 2012. National Baseline Survey Report: Micro, Small and Medium Enterprises in Tanzania. December 2012.

Mobisol Website. 2017. Accessed March 2017. http://www.pluginttheworld.com/mobisol/

Mohammed, Awaddalla H. 2000. *A partial solution for the biomass energy problem in Darfur: Fuel efficient stoves for IDS in Darfur; which is stove is suitable for promotion?* Practical Action – Sudan: NGO report.

Monden, Yasuhiro. 1993. *Toyota Production System: An Integrated Approach to Just-In-Time, 2nd ed.* Industrial Engineering and Management Press, Institute of Industrial Engineers, Norcross, Georgia.

Morehouse, Ward. 1979. "Science, Technology, Autonomy, and Dependence: A Framework for International Debate." *Alternatives,* IV: 387-412

Mumford, Lewis. 1967. *The Myth of the Machine: Technics and Human Development (Vol. 1).* Mariner Books.

…….. 1970. *The Myth of the Machine: The Pentagon of Power (Vol. 2).* Harcour, Brace Jovanovich.

Nakagawa, Sachiko, and Laratta, Rosario. 2010. "How can co-operative banks spread the spirit of cooperation in deprived communities?" *Social Enterprise Journal,* 6(2): 162-180.

Nasir, Anthony, Ali, Tariq Mahmood, Shahdin, Sheikh and Rahman, Tariq Ur. 2011. "Technology achievement index 2009: ranking and comparative study of nations." *Scientometrics,* 87(1):41–62

Noble, David. 1984. *Forces of Production: A Social History of Industrial Automation.* New York: Knopf.

North, Douglas. 1990. *Institutions, Institutional Change and Economic Performance*. Cambridge: Cambridge University Press.

Nyerere, Julius. 1968. *Ujamaa—Essays on Socialism.* Dar es Salaam: Oxford University Press.

…… 1998. Adress by Chairman of the South Centre, to opening of conference on 'Governance in Africa. Addis Ababa, March 2.

Organization for Economic Co-operation and Development – OECD. 1993. *Effective Technology Transfer and Co-operation for Environmentally Sustainable Strategies: Draft Common Reference Paper.* DCD/DAC/ENV(93)4.

Orrnert, Anna. 2006. "Missing pieces: An overview of the institutional puzzle." *Public administration and development,* 26: 449-55.

Ostrom, Elinor. 1990. *Governing the Commons: The evolution of institutions for collective action.* Cambridge University Press.

…….. 2005. "Doing Institutional Analysis: Digging Deeper than Markets and Hierarchies" in C. Me´nard and M. M. Shirley (eds.) *Handbook of New Institutional Economics.* The Netherlands: Springer. Chapter 30: 819–848.

Oxford Dictionaries (website). Search word: Technology. Accessed July 30, 2013. https://oxforddictionaries.com/definition/english/technology.

Oyelaran-Oyeyinka, Banji, and McCormick, Dorothy, eds. 2007. *Industrial Clusters and Innovation systems in Africa: Institutions, Markets and Policy.* Tokyo: United Nations University Press.

Page, John. 2016. "Industry in Tanzania: Performance, prospects, and public policy." Working paper 2016/5 of the United Nations University - World Institute for Development Economic Research (UNU-WIDER).

Palmas, Karl. 2012. "Re-assessing Schumpeterian assumptions regarding entrepreneurship and the social". Social Enterprise Journal, 8(2): 141-155.

Patterson, R. and J. Bozeman. 1999. "Comparativist Study of State and Promotion of Science and Technology. Cases: Botswana and Singapore", chapter in R. Patterson, ed. *Science and Technology and Southern African and East and South Asia*, 116-42. Brill: Leiden.

Peattie, Ken, and Morley, Adrian. 2008. "Eight paradoxes of social enterprise research agenda." *Social Enterprise Journal,* 4(2): 91-107.

Peredo, A.M and McLean, M. 2006. Social entrepreneurship: a critical review of the concept. Journal of World Business 41(1): pp. 56–65.

Pink, Joanna (ed.). 2009. *Muslim Societies in the Age of Mass Consumption: Politics, Culture and Identity between the local and the Global.* Newcastle: Cambridge Scholars Publishing.

Polanyi, Karl, Conrad M. Arensberg and Harry W. Pearson's (eds.). 1957. *Trade and market in early empires: Economies in history and theory.* Glencoe, IL: The Free Press.

Polanyi, Karl. 1957. "The economy as instituted process" in Karl Polanyi, Conrad M. Arensberg and Harry W. Pearson's (eds.) *Trade and market in early empires: Economies in history and theory.* Glencoe, IL: The Free Press. Chapter 13: 243-70.

…….. 1968. *Primitive, Archaic and Modern Economies: Essays of Karl Polanyi,* edited by George Dalton. Garden City, NY: Anchor Books.

……...1944. *The Great Transformation.* Boston: Beacon Press, 1957

Prime Minister's Office, United Republic of Tanzania. 2015. National Private Sector Development Policy. February 2015, Dar es Salaam.

Ram, S. and Jung, Hyung-Shik. 1994. "Innovation in Product Usage: a Comparison of Early Adopters and Early Majority." *Psychology & Marketing,* 11(1): 57-67.

Rametse, Nthati M. and Shah, Hetal. 2012. "Investigating Social Entrepreneurship in Developing Countries." Retrieved from the Social Science Research Network, 11 July 2014, from SSRN: http://ssrn.com/abstract=2176557

Rauniyar, Ganesh P. and Goode, Frank M. 1992. "Technology Adoption on Small Farms." *World Development,* Vol. 20(2): 275-82.

Rensburg, Johann Van, Allda Veidsman, and Micheal Jenkins. 2008. "From Technologists to Social Enterprise Developers: Our Journey as "ICT for Development" Practitioners in Southern Africa." *Information Technology for Development,* Vol. 14(1): 76-89.

Ridley-Duff, Rory and Bull, Mike. 2011. *Understanding Social Enterprise: Theory and Practice.* SAGE Publications.

Ridley-Duff, Roley. 2009. "Co-operative social enterprises: company rules, access to finance and management practice." *Social Enterprise Journal,* 5(1): 50-68

Rodgers, Loren. 2008. "Hybrid Cooperatives: Challenges and Advantages." National Center for Employee Ownership, January 30.

Rogers, Everett. 2003. *Diffusion of Innovations* (5th ed.) Toronto: Free Press.

Rogers, Everett, Singhal, Arvind and Quinlan, Margaret M. 2009. "Diffusion of Innovations" in Don W. Stacks & Michael B. Swalon's (eds.) *An Integrated Approach to Communication Theory and Research, 2nd ed.* NY: Routlodge. Chapter 27, pp. 418-434.

Rosenberg, Nathan. 1972. "Factors affecting the diffusion of technology." *Explorations in Economics History,* Fall.

……1982. *Inside the Black Box: Economy and Technology.* New York: Cambridge University Press.

Roy, Tirthankar. 2002. "Acceptance of innovation in early twentieth-century Indian weaving." *Economic History Review,* LV(3): 507-532.

Rueschemeyer, D. 1991. “Different methods - contradictory results? Research on development and democracy.” *International Journal of Comparative Sociology*, 32(1-2), 9-38

Ruttan, Vernon W. 1997. “Induced Innovation, Evolutionary Theory and Path Dependence: Sources of Technical Change.” *The Economic Journal,* 107 (444): 1520-1529

Science, Technology & Innovation Policy Research Organization (STIPRO). 2010 (June). "The Utility Value of Research and Development (R&D): Where does Tanzania Stand?". Policy Brief, Vol. 1, Issue 1.

Scott, James C. 1999. *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed.* Yale University Press.

Seely, Bruce E. 2003. “Historical Patterns in the Scholarship of Technology Transfer.” *Comparative Technology Transfer and Society,* 1(1): 7-48.

Shaw, K.E. 2002. “Education and Technological Capability Building in the Gulf.” *International Journal of Technology Design and Education,* 12(1): 77-91.

Sheikheldin, Gussai H. 2015. "Ujamaa: Planning and Development Schemes in Africa, Tanzania as a Case Study". Journal of Pan-African Studies, 8(1): 78-96.

Simalenga, Timothy E. 1999. “The Animal Traction Network in East and Southern Afria” in J. F. Devlin and T. Zettel’s (eds.) *Ecoagriculture: Initiatives in Eastern and Southern Africa.* Harare: Weaver Press. Chapter 27: 303-314.

Small, M. L. 2009 (March). “How many cases do I need?’: On science and the logic of case selection in field-based research.” *Ethnography,* 10(1), 5-38

Small Industries Development Organization (SIDO). Corporate Strategic Plan 2014/2015 – 2016-2017. June 2014.

Spear, R. 2006. “Social entrepreneurship: a different model?” *International Journal of Social Economics*, 33(5/6): pp. 399–410

Spreckley, Freer. 1981. *Social Audit – A Management Tool for Co-operative Working.* Beechwood College

Stamp, Patricia. 1990. *Technology, Gender, and Power in Africa.* Ottawa: International Development Research Centre (IDRC).

Stanfield, J. Ron. 1990. “Karl Polanyi and contemporary economic thought” in Kari Polanyi-Levitt’s (ed.) *The life and work of Karl Polanyi.* Montreal: Black Rose Books. Chapter 22: 195-207.

Tanzania Engineering and Manufacturing Design Organization (TEMDO). Strategic Action Plan 2011-2016. April 2011.

Tanzania Domestic Biogas Programme – Phase II. Programme Implementation Document, Revised Version. September 2013.

Tracey, P. and Jarvis, O. 2007. “Toward a theory of social venture franchising.” *Entrepreneurship: Theory and Practice,* Vol. 31 No. 5, pp. 667-85.

Tracey, P., Phillips, N. and Jarvis, O. 2011. “Bridging institutional entrepreneurship and the creation of new organizational forms: a multilevel model.” *Organization Science,* 22(1): 60-80.

The United Nations. 2006. *Gender, Water and Sanitation Case Studies on Best Practices.* New York: United Nations

United Nations Conference on Trade and Development (UNCTAD), Secretariat. 1981. *Planning the Technological Transformation of Developing Coutnries*. Study, Part 49. U.N. Doc. TD/B/C.6/50

United Nations Development Programme (UNDP). 2001. *Making New Technologies Work for Development.* (Summary report)

United Nations Environmental Programme – UNEP. 2008. *Indigenous knowledge in Disaster Management in Africa.* Publication compiled and edited by Peter Mwaura

United Republic of Tanzania, Ministry of Finance and Planning. 2016. "National Five-Year Development Plan 2016/17 – 2020/21: Nurturing Industrialization for Economic Transformation and Human Development." June.

van der Horst, Dan. 2008. "Social enterprise and renewable energy: emerging initiatives and communities of practice." *Social Enterprise Journal,* 4(3): 171-185.

VCD Training. 2005. "The Jatropha Sub-sector: With Emphasis on Jatropha Soap Value Chain. " Case study Report on Kakute Ltd. Experience of value chain development for Jatropha herbal soap. September 2005.

Verschuren, Piet J. M. 2003. "Case study as a research strategy: Some ambiguities and opportunities." *International Journal of Social Research Methodology*, 6(2), 121-139.

Visvanathan, S. 2004. "Technology Transfer." *International Encyclopedia of the Social & Behavioral Sciences,* Pages 15532-37. Amsterdam: Elsevier.

Voss, T. R. 2004. "Institutions." *International Encyclopedia of the Social & Behavioral Sciences,* Pages 7561-66. Amsterdam: Elsevier.

Wejnert, Barbara. 2002. "Integrating Models of Diffusion of Innovations: a Conceptual Framework." *Annual Review of Sociology,* 28: 297-326

Williams, Simon, Christiansen, Amé and Munro, Paul. 2011. "Emerging forms of entrepreneurship: For-profit and non-profit partnerships for the dissemination of solar power into rural sub-Saharan Africa." International Council for Small Business (ICSB). World Conference Proceedings: 1-18, Accessed August 7, 2012. http://search.proquest.com/docview/922574874?accountid=11233

Wolff, Peter. 1999. *Vietnam, the Incomplete Transformation.* London: Frak Cass Publishers.

Woodhouse, Edward, and Patton, Jason W. 2004. "Introduction: Design by Society: Science and Technology Studies and the Social Shaping of Design." *Design Issues* 20(3): 1-12.

Worthington, Steve, Thompson, Frauke Mattison and Stewart, David B. 2011. "Credit cards in a Chinese cultural context—The young, affluent Chinese as early adopters." Journal of Retailing and Consumer Services,18(6): 534-541.

Yu, Xiaomin. 2011. "Social enterprise in China: driving forces, development patterns and legal framework." *Social Enterprise Journal,* 7(1): 9-32.

Yunus, Mohammad. 2008. "Grameen Bank At a Glance." Retrieved 22 March 2008 from: http://www.grameen-info.org/bank/GBGlance.htm

Zahra, S.A., Rawhouser, H.N., Bhawe, N., Neubaum, D.O. and Hayton, J.C. 2008. "Globalization of social entrepreneurship opportunities", *Strategic Entrepreneurship Journal*, 2(2): 117-31.

Zahra, S.A., Gedajlovich, E., Neubaum, D.O., & Shulman, J.M. 2009. A typology of social entrepreneurs: Motives, search processes and ethical challenges. Journal of Business Venturing, 24(5), 519–532.

Zanello, Giacomo, Fu, Xiaolan, Mohnen, Pierre and Ventresca, Marc. 2015. "The Creation and Diffusion of Innovation in Developing Countries: a systematic literature review." *Journal of Economic Surveys*, 30(5): 884-912.

APPENDICES

The following pages contain the appendices of this manuscript. They are:

Appendix I:
Nvivo 10 field data analysis – Coded sources and frequency of themes

Appendix II:
Nvivo 10 field data analysis – coding of interview texts

Appendix III:
Excel analysis of multiple choice-and-rating question

Appendix IV:
MS Excel data analysis – organizing likert-scale answers

Appendix V:
Tables V.1 and V.2 draw criteria for 1) identifying an organization as a social enterprise, and 2) inform decision-making processes by SEs in uptaking technological innovations and promote them for socioeconomic value creation.

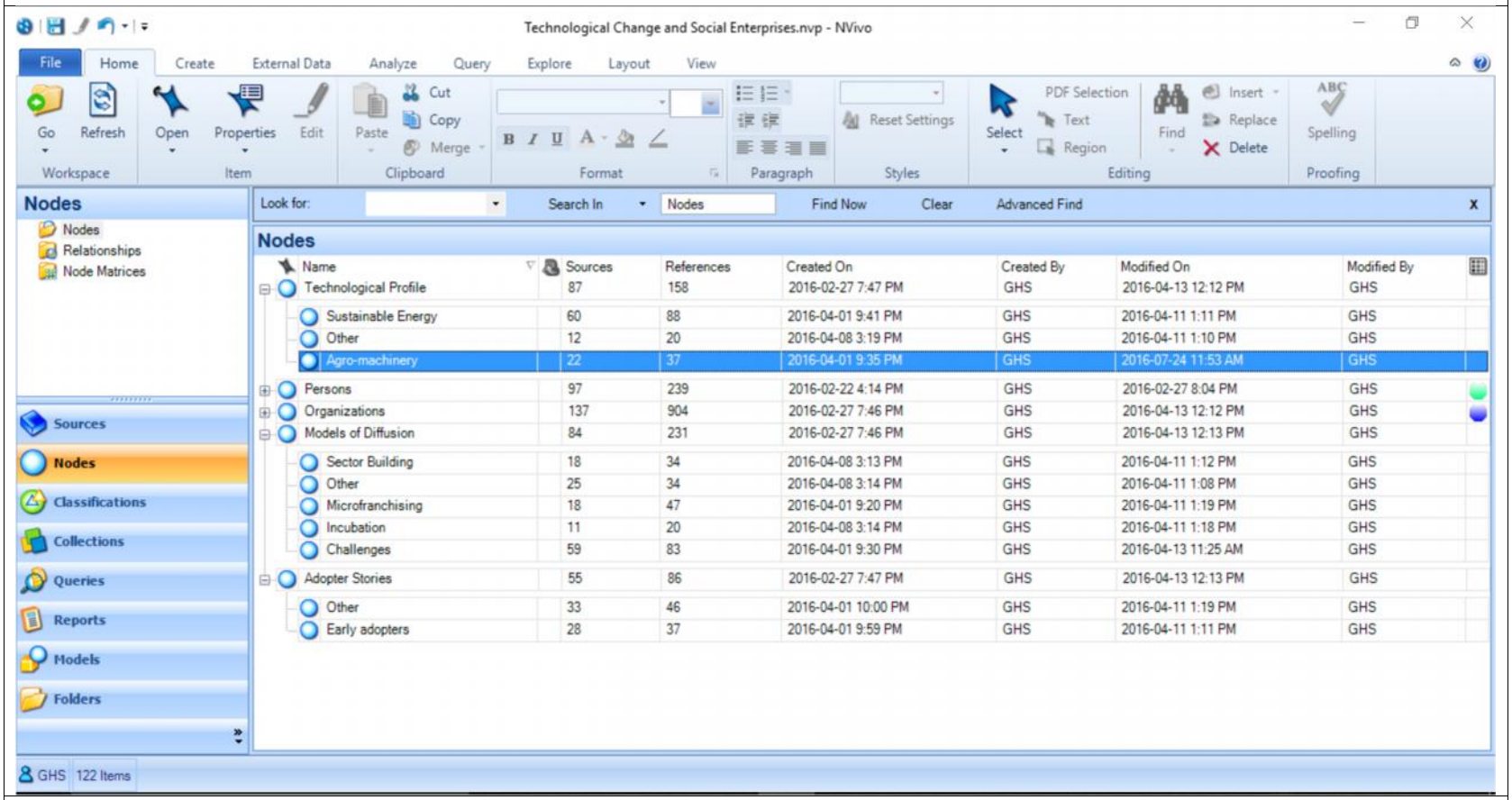
Appendix VI:
Table 9: List of field study interviewees (by codes)

Appendix VII:
Table 10: Responses of interviewees about perceived attributes of technologies

Appendix VIII:
Interview Guide (for technology adopters)

Appendix IX:
Information/recruitment letter for organizations

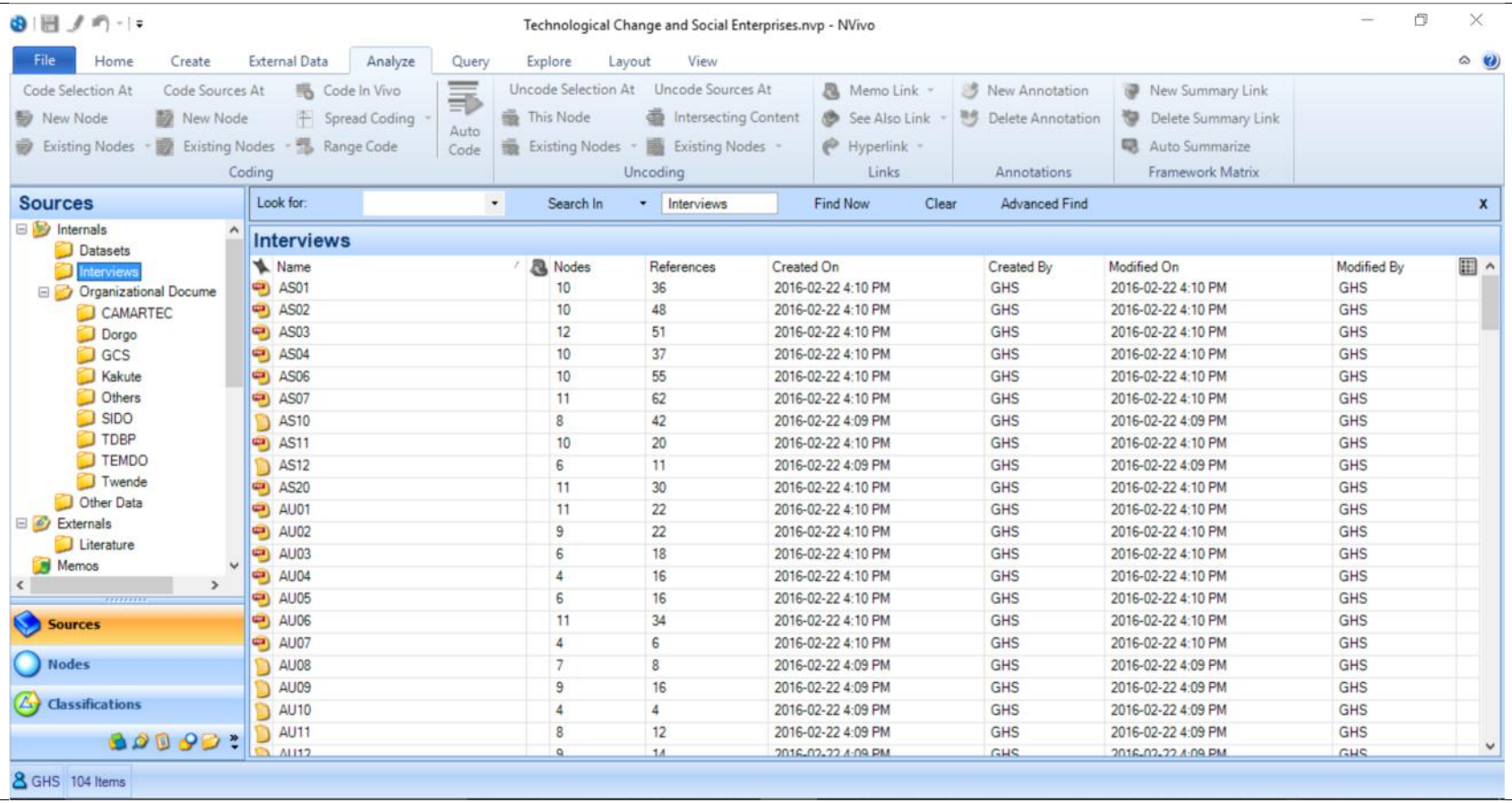
Appendix I: Nvivo 10 field data analysis – Coded sources and frequency of themes*



Name	Sources	References	Created On	Created By	Modified On	Modified By
Technological Profile	87	158	2016-02-27 7:47 PM	GHS	2016-04-13 12:12 PM	GHS
Sustainable Energy	60	88	2016-04-01 9:41 PM	GHS	2016-04-11 1:11 PM	GHS
Other	12	20	2016-04-08 3:19 PM	GHS	2016-04-11 1:10 PM	GHS
Agro-machinery	22	37	2016-04-01 9:35 PM	GHS	2016-07-24 11:53 AM	GHS
Persons	97	239	2016-02-22 4:14 PM	GHS	2016-02-27 8:04 PM	GHS
Organizations	137	904	2016-02-27 7:46 PM	GHS	2016-04-13 12:12 PM	GHS
Models of Diffusion	84	231	2016-02-27 7:46 PM	GHS	2016-04-13 12:13 PM	GHS
Sector Building	18	34	2016-04-08 3:13 PM	GHS	2016-04-11 1:12 PM	GHS
Other	25	34	2016-04-08 3:14 PM	GHS	2016-04-11 1:08 PM	GHS
Microfranchising	18	47	2016-04-01 9:20 PM	GHS	2016-04-11 1:19 PM	GHS
Incubation	11	20	2016-04-08 3:14 PM	GHS	2016-04-11 1:18 PM	GHS
Challenges	59	83	2016-04-01 9:30 PM	GHS	2016-04-13 11:25 AM	GHS
Adopter Stories	55	86	2016-02-27 7:47 PM	GHS	2016-04-13 12:13 PM	GHS
Other	33	46	2016-04-01 10:00 PM	GHS	2016-04-11 1:19 PM	GHS
Early adopters	28	37	2016-04-01 9:59 PM	GHS	2016-04-11 1:11 PM	GHS

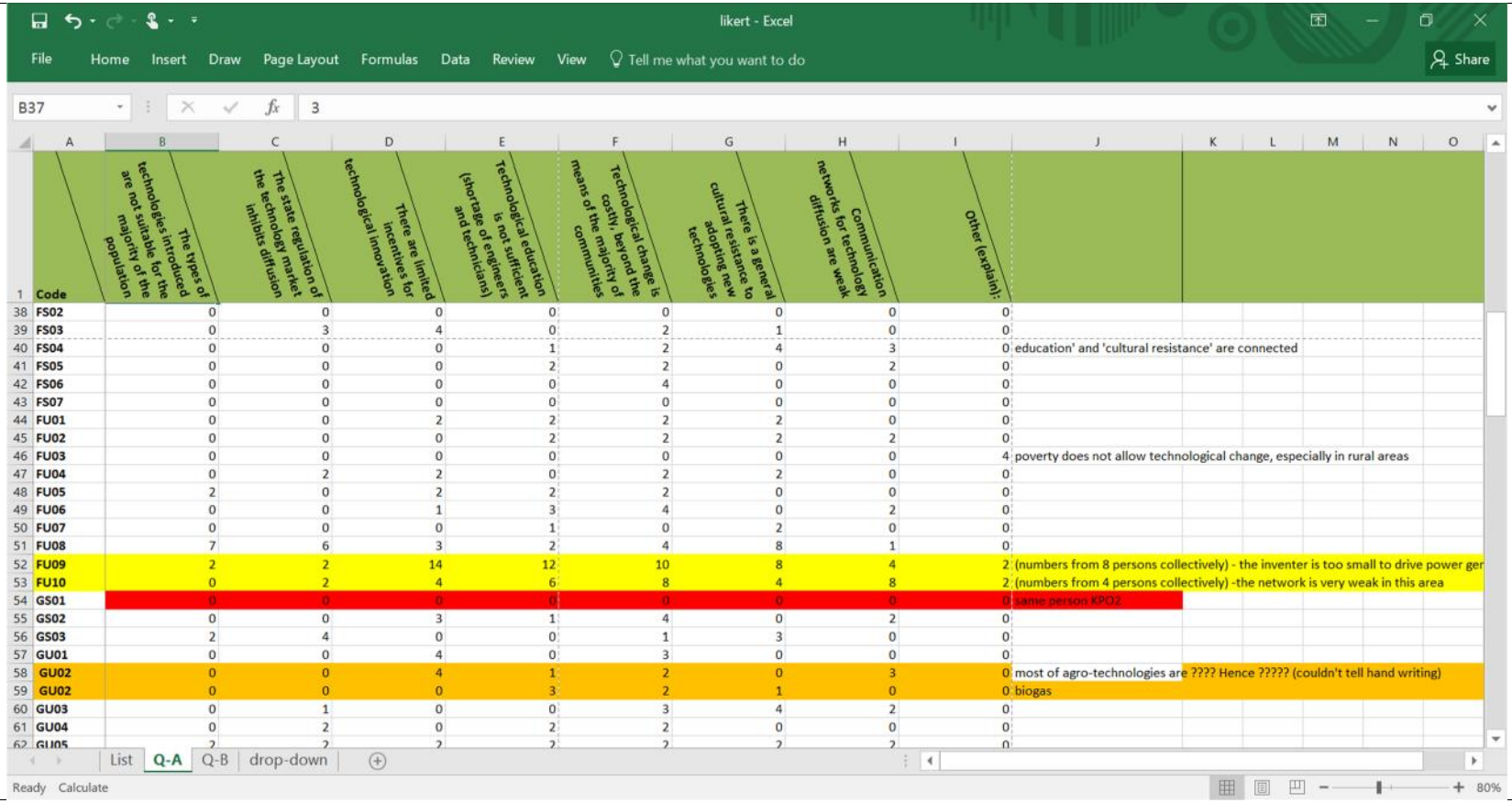
*This screenshot shows ‘nodes’ used to highlight recurring themes and trends in the data collected, especially the interviews

Appendix II: Nvivo 10 field data analysis – coding of interview texts*



*This screenshot shows how each interviewee (with assigned code for name) was coded in various nodes (themes and orgs) to conclude trends and connections.

Appendix III: Excel analysis of multiple choice-and-rating question*



likert - Excel

File Home Insert Draw Page Layout Formulas Data Review View Tell me what you want to do Share

B37 3

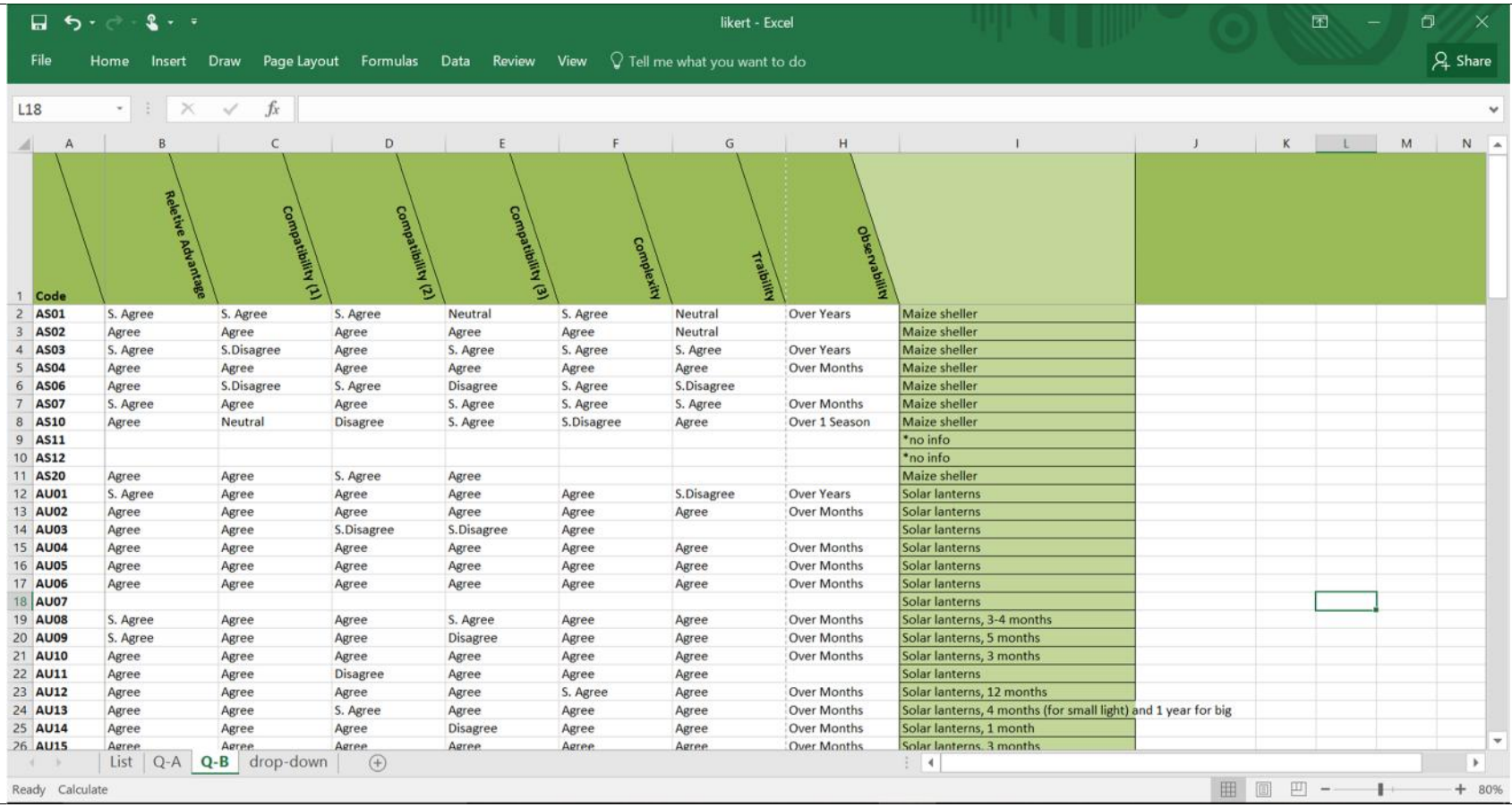
1	Code	The types of technologies introduced are not suitable for the majority of the population	The state regulation of the technology market inhibits diffusion	There are limited incentives for technological innovation	Technological education is not sufficient (shortage of engineers and technicians)	Technological change is costly, beyond the means of the majority of communities	There is a general cultural resistance to adopting new technologies	Communication networks for technology diffusion are weak	Other (explain):	
38	FS02	0	0	0	0	0	0	0	0	
39	FS03	0	3	4	0	2	1	0	0	
40	FS04	0	0	0	1	2	4	3	0	education' and 'cultural resistance' are connected
41	FS05	0	0	0	2	2	0	2	0	
42	FS06	0	0	0	0	4	0	0	0	
43	FS07	0	0	0	0	0	0	0	0	
44	FU01	0	0	2	2	2	2	0	0	
45	FU02	0	0	0	2	2	2	2	0	
46	FU03	0	0	0	0	0	0	0	4	poverty does not allow technological change, especially in rural areas
47	FU04	0	2	2	0	2	2	0	0	
48	FU05	2	0	2	2	2	0	0	0	
49	FU06	0	0	1	3	4	0	2	0	
50	FU07	0	0	0	1	0	2	0	0	
51	FU08	7	6	3	2	4	8	1	0	
52	FU09	2	2	14	12	10	8	4	2	(numbers from 8 persons collectively) - the inventer is too small to drive power ger
53	FU10	0	2	4	6	8	4	8	2	(numbers from 4 persons collectively) -the network is very weak in this area
54	GS01	0	0	0	0	0	0	0	0	same person KPO2
55	GS02	0	0	3	1	4	0	2	0	
56	GS03	2	4	0	0	1	3	0	0	
57	GU01	0	0	4	0	3	0	0	0	
58	GU02	0	0	4	1	2	0	3	0	most of agro-technologies are ???? Hence ????? (couldn't tell hand writing)
59	GU02	0	0	0	3	2	1	0	0	biogas
60	GU03	0	1	0	0	3	4	2	0	
61	GU04	0	2	0	2	2	0	0	0	
62	GU05	2	2	2	2	2	2	2	0	

List Q-A Q-B drop-down

Ready Calculate 80%

*This screenshot shows the excel sheet used to organize and give quantifiable representation to the summary of answers of interviews to a multiple-choice question about the main challenges to technological change in Tanzania.

Appendix IV: MS Excel data analysis – organizing likert-scale answers*



Code	Relative Advantage	Compatibility (1)	Compatibility (2)	Compatibility (3)	Complexity	Trability	Observability	
AS01	S. Agree	S. Agree	S. Agree	Neutral	S. Agree	Neutral	Over Years	Maize sheller
AS02	Agree	Agree	Agree	Agree	Agree	Neutral		Maize sheller
AS03	S. Agree	S.Disagree	Agree	S. Agree	S. Agree	S. Agree	Over Years	Maize sheller
AS04	Agree	Agree	Agree	Agree	Agree	Agree	Over Months	Maize sheller
AS06	Agree	S.Disagree	S. Agree	Disagree	S. Agree	S.Disagree		Maize sheller
AS07	S. Agree	Agree	Agree	S. Agree	S. Agree	S. Agree	Over Months	Maize sheller
AS10	Agree	Neutral	Disagree	S. Agree	S.Disagree	Agree	Over 1 Season	Maize sheller
AS11								*no info
AS12								*no info
AS20	Agree	Agree	S. Agree	Agree				Maize sheller
AU01	S. Agree	Agree	Agree	Agree	Agree	S.Disagree	Over Years	Solar lanterns
AU02	Agree	Agree	Agree	Agree	Agree	Agree	Over Months	Solar lanterns
AU03	Agree	Agree	S.Disagree	S.Disagree	Agree			Solar lanterns
AU04	Agree	Agree	Agree	Agree	Agree	Agree	Over Months	Solar lanterns
AU05	Agree	Agree	Agree	Agree	Agree	Agree	Over Months	Solar lanterns
AU06	Agree	Agree	Agree	Agree	Agree	Agree	Over Months	Solar lanterns
AU07								Solar lanterns
AU08	S. Agree	Agree	Agree	S. Agree	Agree	Agree	Over Months	Solar lanterns, 3-4 months
AU09	S. Agree	Agree	Agree	Disagree	Agree	Agree	Over Months	Solar lanterns, 5 months
AU10	Agree	Agree	Agree	Agree	Agree	Agree	Over Months	Solar lanterns, 3 months
AU11	Agree	Agree	Disagree	Agree	Agree	Agree		Solar lanterns
AU12	Agree	Agree	Agree	Agree	S. Agree	Agree	Over Months	Solar lanterns, 12 months
AU13	Agree	Agree	S. Agree	Agree	Agree	Agree	Over Months	Solar lanterns, 4 months (for small light) and 1 year for big
AU14	Agree	Agree	Agree	Disagree	Agree	Agree	Over Months	Solar lanterns, 1 month
AU15	Agree	Agree	Agree	Agree	Agree	Agree	Over Months	Solar lanterns, 3 months

*This screenshot shows the MS excel formatting used to collect and organize all the responses of interviewees to a series of liker-scale questions about the perceived attributes of technologies diffused by SEs. These questions were answered by SE staff as well as by users/adopters and partners of SEs.

Appendix V:

Tables V.1 and V.2, below, draw criteria for 1) identifying an organization as a social enterprise, and 2) inform decision-making processes by SEs that are interested in taking up innovations and promote them for socio-economic value creation for target beneficiaries. After going through the exercise of recognizing whether an organization qualifies for an SE (Table V.1), the decision-making criteria in table V.2 becomes appropriate to consider. The first step (column 1, table V.2) is to state the claim/justification of the innovation that the SE is thinking about taking up—with different levels of radical claims. After the claim is made it will then need to be verified with a measurable parameter (columns 2 and 3). If the claim is successfully verified, it will then need to be tested against the criteria of 'social value creation'—the one that makes the difference between a conventional/commercial entrepreneurial decision and a social entrepreneurial decision (column 4). An exercise like this allows innovation-inclined SEs to keep themselves in check against imperatives that they voluntarily embrace as business ventures with social missions/goals.

Table V.1: Is it a social enterprise? A check-box for investigation

Criteria	**SE fulfills? (Y/N)**	**How/what (if Y)**	**How planning to fulfill (if N)**
Primary social/environmental objective			
Organization Type (cooperative, credit union, NGO with revenue generation, private firm with surplus investment for public interest, etc.)			
Justified method(s) of surplus investment for public interest (collective/community ownership, fair trade, employment equity/democracy, employee profit-sharing, social programs, etc.)			
Source(s) of revenue: Self-reliant (?%), funding/grants (?%) (if not NGO or relatively new establishment then self-reliant revenue should be significantly larger then funding/grants)			
Long-term goal and vision socially/environmentally oriented			

Table V.2: sample of criteria for considering technologies for uptake or promotion by SEs			
Claim about the innovation	**Criteria to verify**	**Yes?**	**Social value created**
Causes a shift in the market (transformative/disruptive)*	New energy source or way of acquiring service		
	Replaces a current, insufficient, market product/service		
Introduces an innovative system/product that shifts production dynamics in at least one major factor	yield increase of two-folds or closer		
	changes gender relations		
	empowers the local economic cycle		
Ideal appropriate technology type that responds to a known need in communities	Known need verified		
	less capital intensive [and] more labor intensive than the hi-tech versions		
	less dependent on scarce foreign exchange for imported goods		
	easier to maintain, operate and repair		
	labor saving in comparison to traditional methods		

* for this claim, either one of the criteria will suffice

Appendix VI:

Table 9 List of Field Study Interviewees (by codes)				
Code	**Role**	**Gender**	**Association**	**Location**
AS01	SE Staff (lead)	M	GCS	Arusha
AS02	SE Staff (lead)	M	GCS	Arusha
AS03	SE Staff	M	GCS	Arusha
AS04	SE Staff	F	GCS	Arusha
AS06	SE Staff	M	GCS	Arusha
AS07	SE Staff	M	GCS	Arusha
AS10	SE Staff (lead)	F	GCS	Arusha
AS11	SE Staff	M	GCS	Arusha
AS12	SE Staff	F	GCS	Arusha
AS20	SE Staff (former)	M	GCS	Arusha
AU01	Rafiki	F	GCS	Arusha
AU02	Rafiki	F	GCS	Arusha
AU03	Rafiki	F	GCS	Arusha
AU04	Rafiki	F	GCS	Arusha
AU05	Rafiki	M	GCS	Arusha
AU06	Rafiki	F	GCS	Arusha
AU07	Rafiki	M	GCS	Arusha
AU08	Rafiki	M	GCS	Morogoro
AU09	Rafiki	F	GCS	Morogoro
AU10	Rafiki	F	GCS	Morogoro
AU11	Rafiki (and SE staff)	F	GCS	Morogoro
AU12	Rafiki	M	GCS	Morogoro
AU13	Rafiki	M	GCS	Morogoro
AU14	Rafiki	F	GCS	Morogoro
AU15	Rafiki	F	GCS	Morogoro
AU16	Rafiki (and SE staff)	M	GCS	Morogoro
BS01	SE Staff (lead)	M	AISE-Twende	Arusha
BS02	SE Staff	M	AISE-Twende	Arusha
BS03	SE Staff	M	AISE-Twende	Arusha
CS01	SE Staff (lead)	M	AISE-Twende	Arusha
CS03	SE Staff	M	AISE-Twende	Arusha

CS04	SE Staff (lead)	F	AISE-Twende	Arusah
CU01	Partner (lead)	M	ECHO	East Africa
DS01	Staff (lead)	M	RafikiSoft	Global
FP01	Partner (lead)	M	Embark	Arusha
FS01	SE Staff (lead)	M	Kakute	Arusha
FS02	SE Staff	M	Kakute	Arusha
FS03	SE Staff	F	Kakute	Arusha
FS04	SE Staff (lead)	F	Kakute	Arusha
FS05	SE Staff	M	Kakute	Arusha
FS06	SE Staff	F	Kakute	Arusha
FS07	SE Staff	M	Kakute	Arusha
FU01	Kakute/Mobisol client	M	Kakute	Arusha (Ngusero)
FU02	Same as above	M	Kakute	Arusha (Ngusero)
FU03	Same as above	M	Kakute	Arusha (Ngusero)
FU04	Same as above	F	Kakute	Arusha (Ngusero)
FU05	Same as above	M	Kakute	Arusha (Ngusero)
FU06	Kakute client (group A)	F	Kakute	Arusha (Longido)
FU07	Kakute client (group A)	F	Kakute	Arusha (Longido)
FU08	Kakute client (group A) (lead)	M	Kakute	Arusha (Longido)
FU09	8 users of solar home systems. Kakute/Mobisol clients	M	Kakute	Arusha (Longido)
FU10	4 users of solar home systems. As as bove.	M	Kakute	Arusha (Longido)
GS01	SE Staff (lead)	M	Dorgo Agro Enterprises	Arusha
GS02	SE Staff	M	Dorgo Agro Enterprises	Arusha
GS03	SE Staff	M	Dorgo Agro Enterprises	Arusha
GU01	Partner (lead)	M	Selian Agricultural Research Institute	Arusha

GU02	Dorgo client	M		Kilimanjaro (Hai)
GU03	Dorgo client	M	MayoVega Group (Mawene Young Vegetable Growth Association)	Arusha (Maweni)
GU04	Dorgo client	M		Arusha (Morombo)
GU05	Dorgo client	M	Sokoine University of Agriculture, Arusha Branch	Arusha (Ngaramtoni)
GU06	Dorgo client	M	Nelson Mandela African Institute of Science & Tech.	Arusha (Shangarai)
KP01	Partner	F	CAMARTEC	
KP02	Partner (lead)	M	CAMARTEC	
KP03	Partner	M	CAMARTEC	
KP04	Partner	F	CAMARTEC	
KP05	Partner (lead)	M	CAMARTEC	
KP06	Partner	M	CAMARTEC	
LP01	Partner	M	TEMDO	Arusha
MP01	Partner	M	MVIWATA	Arusha
SP01	Partner (lead)	M	SIDO	Arusha
TS01	Staff (lead)	M	TDBP	National
TS02	Staff	M	TDBP	National
TS03	Program partner	F	Evangelical Lutheran Church in Tanzania	Kilimanjaro, Njombe (Iringa), Arusha, Mara
TS04	Program partner	M	Friends in Development (local NGO).	Manyara (Babati)
TSU06	BCE member (lead) (certified mason)	M	TDBP	Manyara
TSU07	BCE member (certified mason)	M	TDBP	Arusha and Mwanza
TSU08	BCE member (lead) (certified mason)	M	TDBP	Mwanza
TSU09	BCE member (lead) (certified mason)	M	TDBP	Kilimanjaro (Same + Moshi)

TSU10	Mason	M	TDBP	Kilimanjaro (Same + Moshi)
TSU11	BCE member (lead) (certified mason)	M	TDBP	Arusha (Kitatiti)
TSU12	BCE member (lead) (certified mason)	M	TDBP	Arusha (Kitatiti)
TSU13	BCE member (certified mason)	M	TDBP	Arusha (Ngaramtoni)
TSU14	BCE member (certified mason)	M	TDBP	Arusha (Ngaramtoni)
TSU20	BCE member (lead)	M	TDBP	Manyara (Bermi)
TSU23	BCE member (lead)	F	TDBP	Manyara (Bermi)
TU15	Farmer with biogas digester	M		Kilimanjaro (Same)
TU16	Farmer with biogas digester	M		Kilimanjaro (Same)
TU17	Entrepreneur with biogas digester and big animal farm	F		Kilimanjaro (Saweni)
TU18	Farmer and livestock keeper	F		Arusha (Ngaramtoni)
TU19	Farmer and livestock keeper	F		Manyara (Bermi)
TU21	Gardener	M		Manyara (Bermi)
TU22	Gardener	M		Manyara (Bermi)
TU24	Gardener	F		Manyara (Bermi)
TU25	Entrepreneur	F		Manyara (Bermi)
XX01	Informant (lead)	F	STIPRO	Dar es Salaam
XX02	Partner (lead)	M	SNV	Arusha

Appendix VII:

Table 10 Responses of interviewees about perceived attributes of technologies*

Code	Relative Advantage	Compatibility (1)	Compatibility (2)	Compatibility (3)	Complexity	Trialability	Observability	Technology/product
AS01	S. Agree	S. Agree	S. Agree	Neutral	S. Agree	Neutral	Over Years	Maize sheller
AS02	Agree	Agree	Agree	Agree	Agree	Neutral		Maize sheller
AS03	S. Agree	S.Disagree	Agree	S. Agree	S. Agree	S. Agree	Over Years	Maize sheller
AS04	Agree	Agree	Agree	Agree	Agree	Agree	Over Months	Maize sheller
AS06	Agree	S.Disagree	S. Agree	Disagree	S. Agree	S.Disagree		Maize sheller
AS07	S. Agree	Agree	Agree	S. Agree	S. Agree	S. Agree	Over Months	Maize sheller
AS10	Agree	Neutral	Disagree	S. Agree	S.Disagree	Agree	Over 1 Season	Maize sheller
AS11								*no info
AS12								*no info
AS20	Agree	Agree	S. Agree	Agree				Maize sheller
AU01	S. Agree	Agree	Agree	Agree	Agree	S.Disagree	Over Years	Solar lanterns
AU02	Agree	Agree	Agree	Agree	Agree	Agree	Over Months	Solar lanterns
AU03	Agree	Agree	S.Disagree	S.Disagree	Agree			Solar lanterns
AU04	Agree	Agree	Agree	Agree	Agree	Agree	Over Months	Solar lanterns
AU05	Agree	Agree	Agree	Agree	Agree	Agree	Over Months	Solar lanterns
AU06	Agree	Agree	Agree	Agree	Agree	Agree	Over Months	Solar lanterns
AU07								Solar lanterns
AU08	S. Agree	Agree	Agree	S. Agree	Agree	Agree	Over Months	Solar lanterns, 3-4 months
AU09	S. Agree	Agree	Agree	Disagree	Agree	Agree	Over Months	Solar lanterns, 5 months
AU10	Agree	Agree	Agree	Agree	Agree	Agree	Over Months	Solar lanterns, 3 months
AU11	Agree	Agree	Disagree	Agree	Agree	Agree		Solar lanterns
AU12	Agree	Agree	Agree	Agree	S. Agree	Agree	Over Months	Solar lanterns, 12 months
AU13	Agree	Agree	S. Agree	Agree	Agree	Agree	Over Months	Solar lanterns, 4 months (for small light) and 1 year for big
AU14	Agree	Agree	Agree	Disagree	Agree	Agree	Over Months	Solar lanterns, 1 month

AU15	Agree	Agree	Agree	Agree	Agree	Agree	Over Months	Solar lanterns, 3 months
AU16	Agree	Agree	Agree	Disagree	Agree	Agree	Over Years	Solar lanterns, 1 year
BS01	Agree	Agree	Neutral	S.Disagree	Agree	Agree	Over Years	general, seven years
BS02	S.Disagree	S.Disagree	Disagree	Disagree	S.Disagree	Disagree	Over 1 Season	
BS03	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral		
CS01	Agree	Agree	Agree	S.Disagree	S. Agree	Agree	Over Months	drip irrigation system (after one season) and solar water heater (after a few years)
CS03	S. Agree	S. Agree	Agree	S. Agree	Agree	Agree	Over Months	drip irrigation system (one year) and solar water heater (two years)
CS04	Neutral	S. Agree	S. Agree	Neutral	Neutral	Agree	Over Months	drip irrigation system (one year) and solar water heater (two years)
CU01	S. Agree	Agree	Agree	S. Agree	Agree	Disagree	Over Months	3-4 months
DS01	Agree	S. Agree	Neutral	Neutral	S.Disagree	Agree	Over Months	
FP01								*no info
FS01								*no info
FS02								*no info
FS03	S. Agree	S. Agree	Neutral	Neutral	Neutral	Neutral	Immediately	
FS04	Agree	Agree	S.Disagree	S. Agree	Agree	Agree	Over Years	solar and biogas (2-3 years)
FS05	Agree	Agree	Agree	S. Agree	Agree	Neutral	Over Months	
FS06	Agree	Agree	Agree	Agree	Agree	S. Agree	Over Years	solar home systems, 5 years
FS07								
FU01	Agree	Agree	Agree	Agree		Agree	Over Years	
FU02	Agree	Agree	Agree	S. Agree	Agree	Agree	Immediately	
FU03	Agree	Agree	S. Agree	S. Agree	Agree	Agree	Over Years	
FU04	Agree	Agree	S. Agree	S.Disagree	S. Agree	S.Disagree	Over Years	
FU05	Agree	Agree	Agree	Agree	Agree	S.Disagree	Over Years	
FU06	S. Agree	Neutral	Disagree	Neutral	Agree	S. Agree		
FU07	Agree	Agree	S. Agree	S. Agree	Agree	Agree	Over Months	3 months
FU08	Agree	Agree	Agree	Disagree	Agree	S.Disagree	Over Years	3 years

FU09	S. Agree	Agree	Neutral	S.Disagree	Neutral	Neutral		solar systems, multiple respondents (8)
FU10	Agree	Agree	S. Agree	Agree	Neutral	Neutral		solar systems, multiple respondents (4)
GS01								*no info
GS02	Agree	Agree	S. Agree	Agree	S. Agree	Agree	Over Months	agro-machineries
GS03	Agree	Agree	S. Agree	Agree	S. Agree	Agree	Over 1 Season	
GU01	Agree	Agree	Agree	Agree	Agree	Agree	Over Months	
GU02	Agree	Agree	S. Agree	Neutral	S. Agree	Neutral	Over Years	4 years
GU03	Agree	Agree	Agree	Disagree	Agree	Agree	Over 1 Season	
GU04	S. Agree	S.Disagree	S. Agree	Agree	Agree	S.Disagree	Over Years	
GU05	Agree	Agree	Agree	Agree	Agree	Agree	Immediately	
GU06	S. Agree	Agree	Disagree	Neutral	S. Agree	Agree	Over Years	less than 2 years
KP01								*no info
KP02								same as GS01
KP03								*no info
KP04								*no info
KP05								*no info
KP06								*no info
LP01								*no info
MP01								*no info
SP01								*no info
TS01	Agree	Agree	Disagree	Agree	Agree		Over Years	Biogas (lasts for 20 years)
TS02	Agree	Agree	S. Agree	Agree	Agree	Agree	Over Years	2 years
TS03	Agree	Agree	Disagree	Disagree	Agree	Disagree	Over Years	
TS04	Agree	Agree	S.Disagree	S. Agree	Agree	S. Agree	Over Months	
TSU06	Agree	Agree	Agree	Agree	Agree	Agree	Over Months	12 months
TSU07	Agree	Agree	Agree	Agree	Agree	Agree	Over Months	6 months
TSU08	Agree	Agree	S. Agree	Disagree	S. Agree	S. Agree	Over Months	16 months
TSU09	Agree	Agree	S. Agree	Agree	S. Agree	Agree	Over Years	
TSU10	Agree	Agree	Agree	Agree	Agree	S. Agree	Over Years	

TSU11	Agree	Agree	Agree	Disagree	Agree	Agree	Over Months	6 months
TSU12	Agree	Agree	S. Agree	Agree	Agree	Agree	Over Months	11 months
TSU13	Agree	Agree	Agree	Agree	Agree	Agree		
TSU14	Agree	Agree	S. Agree	Disagree	S. Agree	Agree	Over Years	2 years
TSU20	Agree	Agree	Agree	Agree	Agree	Agree	Over Months	6 months
TSU23	Agree	Agree	Disagree	Disagree	Disagree	Disagree	Over Years	1 year
TU15	Agree	Agree	Agree	Disagree	Agree	S. Agree	Over Years	5 years
TU16	Agree	Agree	Agree	Agree	Agree	Agree		
TU17	Agree	Agree	Agree	Disagree	Agree	Agree	Over Years	1 year
TU18		S. Agree		S. Agree	Agree	Disagree	Over Years	
TU19	Agree	Agree	Agree	Agree	Agree	Agree	Over Years	1 year
TU21	Agree	Agree	Agree	Agree	Agree	Agree		
TU22	Agree	Agree	Disagree	Agree	Agree	Agree		
TU24	Agree	Agree	Agree	Agree	Agree	Agree		
TU25	Agree	Agree	S. Agree	S. Agree	Agree	Agree	Over Years	1 year
XX01								*no info
XX02								*no info

*The questions were presented in likert-scale format. Each question had 5 scales: Disagree, Somewhat Disagree, Neutral, Somewhat Agree, and Agree. In the last question on observability the interviewee was asked to tell how long does it take to see a return on first investment (or payment) for the technology in question; the options were: immediately, over one season, over months, or over years (mention number of months or years if chosen). Questions were presented as below:

Please state your level of agreement with each of the statements below:

Relative Advantage:

Compared to the commonly available technology performing the same function in your community, this technology is generally more effective.

Compatibility (x3):

(1) This technology is suitable to the local environmental conditions of this country/region

(2) This technology is affordable to the majority of the target population

(3) This technology invoked cultural changes in targeted communities (if agree explain, and whether it's favorable or unfavorable)

Complexity:

This technology is easy to understand, operate and maintain by the local users

Trialability (if applicable):

This technology can be sufficiently tried first to determine whether to adopt or not before complete purchase or change

Observability (if applicable): *The return of investment in this technology can be witnessed over the following length of time*

Appendix VIII:
Interview Guide (for technology adopters)

Technological Development and Social Enterprises in Africa:

Challenges and opportunities of diffusion

Interview Guide (for users and micro-distributers of technologies which are diffused by case social enterprises)

I. Background of Interviewee (in relevance to the research topic)

1. What is your business/vocation? And how are you using the technology provided by the SE?

II. Business with the social enterprise(s) and the products/services involved

2. What type of entity is yours officially registered as? (if applicable)
3. What do you see the major challenges to technological development in this country/region? (Examples given below, optional)

	The types of technologies introduced are not suitable for the majority of the population		Technological change is costly, beyond the means of the majority of communities
	State regulation of the technology market inhibits diffusion		There is a general cultural resistance to adopting new technologies
	There are limited incentives for technological innovation		Communication networks for technology diffusion are weak
	Technological education is not sufficient (such as shortage of engineers and technicians)		Other (explain):

4. Which of the technologies, provided by the social enterprise you do business with, do you use or distribute?
5. Tell us about each product or service you receive from your partner social enterprise:

III. How communication and marketing for the products/services was conducted

6. How did you first hear about the social enterprise and its products/services?
7. Were you interested in the products/services of the social enterprise from the first time, or not right away?
8. Can you describe the marketing approach of the social enterprise, as you understand it?

9. How do you generally rate the communication and marketing approach of the social enterprise? For example:

Poor (needs work)	Sufficient (could be better)	Good (satisfying)	Excellent (exceptional)

10. From your perspective, recount the advantages and disadvantages of the communication and marketing approach of the social enterprise.

IV. Perceived Attributes of Technologies

(Below are questions to evaluate perception of the technologies being diffused by the organization. The questions should be asked about each single technology product/service of interest for this research).

11. Is this technology totally new to the market targeted, or is it an incremental improvement to existing products? Explain.
12. Does the technology introduce an innovative system/product that shifts production dynamics in at least one major dimension? If so, what are these dimensions (i.e. changes gender relations to more equal power, increases yield two-fold or more, enhances local economic cycle, etc.)
13. Are there other, but less dramatic, changes that this technology introduces? Explain.
14. Please state your level of agreement with each of the statements below:

Relative Advantage:

Compared to the commonly available technology performing the same function in your community, this technology is generally more effective.

Disagree	Somewhat Disagree	Neutral (or don't know)	Somewhat Agree	Agree

Compatibility (x3):

This technology is suitable to the local environmental conditions of this country/region

Disagree	Somewhat Disagree	Neutral (or don't know)	Somewhat Agree	Agree

This technology is affordable to the majority of the target population

Disagree	Somewhat Disagree	Neutral (or don't know)	Somewhat Agree	Agree

This technology invoked cultural changes in targeted communities (if agree explain, and whether it's favorable or unfavorable)

Disagree	Somewhat Disagree	Neutral (or don't know)	Somewhat Agree	Agree

Complexity:
This technology is easy to understand, operate and maintain by the local users

Disagree	Somewhat Disagree	Neutral (or don't know)	Somewhat Agree	Agree

Trialability (if applicable):
This technology can be sufficiently tried first to determine whether to adopt or not before complete purchase or change

Disagree	Somewhat Disagree	Neutral (or don't know)	Somewhat Agree	Agree

Observability (if applicable):
The return of investment in this technology can be witnessed over the following length of time

Immediately	Over one season or salary period	Over a few months (approx. how many)	Over a few years (approx. how many)

IV. Recognition and Engagement of Early Adopters

15. Do you hold any leadership role or conduct leadership activities in your community? And if yes, please elaborate.
16. Describe your general connections and investments in this community. Do you have a long-term investment in the well-fare of the community?
17. What are the major economic relations you have with the members of this community (i.e. employer, merchant, family business, skilled employee, labourer, etc.)
18. What have you done in your community, so far, to promote the technologies in question?

VII. Perceived Challenges and Opportunities of Business

19. What are the main challenges in your relation with the social enterprise? And how do you see they could be resolved?
20. What is the most interesting story of your business experience with the social enterprise or with its products/services?
21. Are there any additional comments, observations, or recommendations you would like to share with us?

Appendix IX:
Information/recruitment letter for organizations

RESEARCH INFORMATION LETTER (FOR PARTICIPANT ORGANIZATIONS)
FOR THE RESEARCH PROJECT ENTITLED

Technological Development and Social Enterprises in Africa:
Challenges and Opportunities for Diffusion

You are asked to participate in a research study conducted by Gussai Sheikheldin, Dr. John Devlin, Dr. Nonita Yap and Dr. Adam Sneyd from the University of Guelph (Canada). The results of this study will be used, in the form of a dissertation authored by Gussai Sheikheldin towards completion of a Doctorate degree in Rural Studies. This study is funded through a research grant by the International Development Research Centre (IDRC), the Canadian federal agency, established in 1970, that supports research in developing countries to promote growth and development.

If you have any questions or concerns about the research, please feel free to contact Gussai Sheikheldin by email: gsheikhe@uoguelph.ca or Dr. John Devlin 519 824 4120 x 52575 (email jdevlin@uoguelph.ca).

PURPOSE OF THE STUDY
This study seeks to understand the challenges and opportunities faced by social enterprises in promoting technological change in rural Africa. Technological change is important for agricultural and rural development. But technological change in rural Africa faces many challenges. Some of these challenges are evident in the slowness of adopting new useful technologies, the scarcity of information among the rural population about available alternative technologies, and the financial limitations that make it difficult to adopt new technologies.This research asks whether social enterprises are successful agents of technological change in Africa and what conditions influence their success. The research will explore case studies of technology-oriented social enterprises in Tanzania. The research will collect data from participant organizations and individuals through key informant interviews and field observations.

PROCEDURES
If your organization agrees to participate in this study, we will ask your organization to do the following things:

1. Accept that your staff can participate in interviews conducted by the student investigator, Gussai Sheikheldin. There will be an information letter and consent form provided to each individual staff selected for an interview.
2. Allow the student investigator to accompany your operations staff and observe your operations related to technology diffusion first hand, for about 3-4 weeks (working hours only). It is within your discretion to allow the student investigator access to certain activities and keep him from access to others as you see fit. It is also within your organization's discretion to allow your staff to answer the questions that may arise from the student investigator's field observations.
3. We will also ask your organization to allow us access to some of your organization's documents (including pictures, videos, and other forms of media) pertaining to your organizational model and activities pertaining to technology diffusion. The research team will make use of only those official documents which your organization allow us to have access to.

We have provided you with our contact information. You may contact us at any point if you have any questions. A pdf of research results will be emailed to all participants who request a copy.

POTENTIAL RISKS AND DISCOMFORTS
We anticipate that your organization faces no risk associated with participating in this project. During the time when the student investigator is taking field observation notes, if the host organization decides the student shall no longer continue to collect data, the student will stop collecting data as per the request of the organization's representative(s).

CONFIDENTIALITY
Every effort will be made to ensure the confidentiality of all identifying information that is obtained during this study. A coding system will be used instead of directly identifying information of your staff, customers or partners. Over the course of this project, all data will be accessed only by the researchers, in addition to a Swahili interpreter/translator who will sign a confidentiality agreement with the research team as part of his/her contract. With the completion of the project all the identifying data will be destroyed. The research team would like to identify the organizations who are participating in this research but we will not do so without your permission.

POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY
Your organization will have an opportunity to bring more visibility to its work in technology diffusion. Your organization will have exposure to academic study and this may illuminate areas for potential improvement. Participating in this research can also be a window to inform policy and research of what institutional changes could be made to help social enterprises in their missions. The results of the study may encourage increased engagement with social enterprises by development donors.

PAYMENT FOR PARTICIPATION
There will be no payment for participation.

PARTICIPATION AND WITHDRAWAL
You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may exercise the option of removing your data from the study. You may also refuse to answer any questions you don't want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise that warrant doing so.

RIGHTS OF RESEARCH PARTICIPANTS
You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. This study has been reviewed and received ethics clearance through the University of Guelph Research Ethics Board. If you have questions regarding your rights as a research participant you may contact:

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